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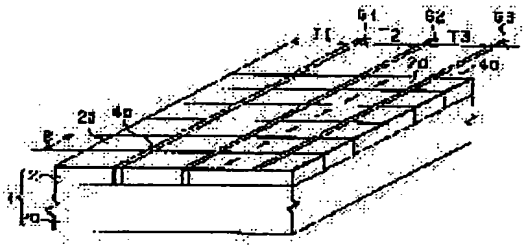
(54) MAGNETIC DISK, PRODUCTION OF MAGNETIC DISK AND MAGNETIC RECORDER

(57)Abstract:
PROBLEM TO BE SOLVED: To increase the density of magnetic recording by separating recording magnetic members from each other by hard guard band members.
SOLUTION: A substrate 1a is provided thereon with a recording layer 2. This recording layer 2 includes band-shaped magnetic members 2a long in the direction of the recording tracks and the guard band members 4a consisting of different materials embedded between these members 2a. The magnetic members 2a and the guard band members 4a are periodically and alternately arranged with the track pitch as one period in the radial direction of the disk in the recording layer 2. The track pitch is given by (T+G) and the effective recording magnetic domain area corresponding to the inverse number of the surface density is given by (T × G) × B when the width of the band-shaped recording magnetic members 2a, i.e., recording track width, is defined as T and the width of the band-shaped guard band members 4a, i.e., guard band width, as G and the length of the recording magnetic domains as B. The surface recording density attains about 1.5Gbpsi and the storage capacity with the drive of the four surfaces of two sheets of the disk attains 1.5GB when a disk substrate of a 2.5-inch size is used for the disk substrate 1 and the red track width T is set at 1.8±0.1μm and the guard width G at 0.2±0.1μm.



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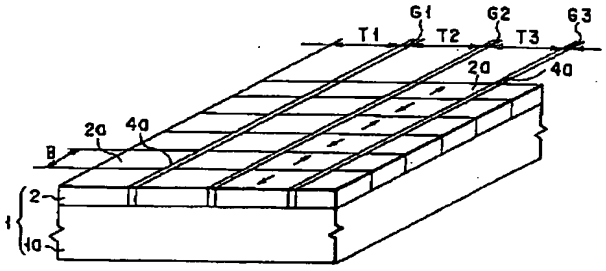
(54)【発明の名称】　磁気ディスク、磁気ディスクの製造方法、及び磁気記録装置

(57)【要約】
【課題】　記録磁区のサイドフリンジを低減することができ、磁気ヘッドの位置決め精度を狭スペーシング時にも向上させることができる磁気ディスクを提供する。
【解決手段】　基板と、この基板上に設けられ、情報を磁気的に記録再生する磁性部材でつくられた記録トラック部と、互いに隣接する前記記録トラック部間にトラック方向に実質的に連続するように設けられ、前記磁性部材よりも硬く、かつ非磁性の材料でつくられたガードバンド部材と、を具備し、上記ガードバンド部材の下方領域には、上記磁性部材が存在しないか、又は、上記記録トラック部をなす磁性部材の厚みとは異なる厚みの磁性部材が設けられている。



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【特許請求の範囲】

【請求項１】　基板と、この基板上に設けられ、情報を磁気的に記録再生する磁性部材でつくられた記録トラック部と、互いに隣接する前記記録トラック部間にトラック方向に実質的に連続するように設けられ、前記磁性部材よりも硬く、かつ非磁性の材料でつくられたガードバンド部材と、を具備し、

上記ガードバンド部材の下方領域には、上記磁性部材が存在しないか、又は、上記記録トラック部をなす磁性部材の厚みとは異なる厚みの磁性部材が設けられていることを特徴とする磁気ディスク。

【請求項２】　上記ガードバンド部材の電気抵抗のほうが、上記記録トラック部をなす磁性部材の電気抵抗よりも大きいことを特徴とする請求項１記載の磁気ディスク。

【請求項３】　上記磁性部材と上記ガードバンド部材とで形成されるディスク表面が実質的に平坦であることを特徴とする請求項１又は２のいずれかに記載の磁気ディスク。

【請求項４】　上記ガードバンド部材の厚みは、上記記録トラック部をなす磁性部材の厚みと実質的に同じであることを特徴とする請求項１記載の磁気ディスク。

【請求項５】　上記ガードバンド部材の厚みは、上記記録トラック部をなす磁性部材の厚みより小さいことを特徴とする請求項１記載の磁気ディスク。

【請求項６】　上記ガードバンド部材の厚みは上記記録トラック部をなす磁性部材の厚みより大きく、上記ガードバンド部材の一部が基板のなかに埋設されていることを特徴とする請求項１記載の磁気ディスク。

【請求項７】　さらに、上記磁性部材と基板との間にＮｉＰメッキ層、Ｃｒ配向制御層、ＮｉＦｅ軟磁性層のうちのいずれかからなる下地層を有し、

上記ガードバンド部材の厚みは、この下地層の厚みと上記磁性部材の厚みとを合計した厚みと実質的に同じであることを特徴とする請求項１記載の磁気ディスク。

【請求項８】　基板と、この基板上に設けられ情報を磁気的に記録再生する磁性部材でつくられた記録トラック部と、互いに隣接する前記記録トラック部間にトラック方向に実質的に連続するように設けられ、上記記録トラック部をなす磁性部材とは磁気的に異なる材料でつくられ、外部に直流磁界を供給する磁石部材と、を備えることを特徴とする磁気ディスク。

【請求項９】　上記磁性部材と上記磁石部材とで形成されるディスク表面が実質的に平坦であることを特徴とする請求項８記載の磁気ディスク。

【請求項１０】　上記磁石部材の厚みは、上記記録トラック部をなす磁性部材の厚みと実質的に同じであることを特徴とする請求項８記載の磁気ディスク。

【請求項１１】　上記磁石部材の厚みは、上記記録トラック部をなす磁性部材の厚みより小さいことを特徴とする請求項８記載の磁気ディスク。

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【請求項１２】　上記磁石部材の厚みは上記記録トラック部をなす磁性部材の厚みより大きく、上記磁石部材の一部が基板のなかに埋設されていることを特徴とする請求項８記載の磁気ディスク。

【請求項１３】　さらに、上記磁性部材と基板との間にＮｉＰメッキ層、Ｃｒ配向制御層、ＮｉＦｅ軟磁性層のうちのいずれかからなる下地層を有し、

上記磁石部材の厚みは、この下地層の厚みと上記磁性部材の厚みとを合計した厚みと実質的に同じであることを特徴とする請求項８記載の磁気ディスク。

【請求項１４】　上記磁石部材は、記録用磁気ヘッドによって磁化方向が変化しないような大きさの保磁力を有する材料でできていることを特徴とする請求項８記載の磁気ディスク。

【請求項１５】　（ａ）実質的に平坦な表面をもつ基板上に磁性材料からなる磁性層を形成する工程と、

（ｂ）この磁性層の一部を除去してトラック方向に実質的に連続するように互いに隣接する記録トラック部を規定するガードバンドスペースをパターン形成する工程と、

（ｃ）このガードバンドスペースを、前記磁性層をなす磁性材料よりも硬く、かつ非磁性の材料からなるガードバンド部材で満たす工程と、

（ｄ）このガードバンド部材及び前記磁性層の表面がそれぞれ実質的に平坦になるように加工する工程と、を備えることを特徴とする磁気ディスクの製造方法。

【請求項１６】　（Ａ）実質的に平坦な表面をもつ基板上に磁性材料からなる磁性層を形成する工程と、

（Ｂ）この磁性層の一部を除去してトラック方向に実質的に連続するように互いに隣接する記録トラック部を規定するスペースをパターン形成する工程と、

（Ｃ）このスペースを、前記磁性材料とは磁気的に異なる材料でつくられ、外部に直流磁界を供給する磁石部材で満たす工程と、

（Ｄ）この磁石部材及び前記磁性層の表面がそれぞれ実質的に平坦になるように加工する工程と、を備えることを特徴とする磁気ディスクの製造方法。

【請求項１７】　基板と、この基板上に設けられ、情報を磁気的に記録再生する磁性部材でつくられた記録トラック部と、互いに隣接する前記記録トラック部間にトラック方向に実質的に連続するように設けられ、前記磁性部材よりも硬く、かつ非磁性の材料でつくられたガードバンド部材と、を具備し、上記ガードバンド部材の下方領域には、上記磁性部材が存在しないか、又は、上記記録トラック部をなす磁性部材の厚みとは異なる厚みの磁性部材が設けられている磁気ディスクに対して、情報を磁気的に読み込み書き込む磁気ヘッドと、外部装置から送られてくる書き込み情報をデータ処理し、データ処理された情報をリードライト回路を介して前記磁気ヘッド

に送る制御部と、を備え、
上記磁気ヘッドはスピンバルブ型の磁気抵抗素子を具備し、
このスピンバルブ型の磁気抵抗素子は、
上記リードライト回路に接続され、上記磁気ディスクの面に垂直方向に磁化が固定された第１の磁性層と、
磁化が印加磁界により変化する第２の磁性層と、
この第２の磁性層と上記第１の磁性層との間に挿入された非磁性導電層と、
を備えていることを特徴とする磁気記録装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、主に計算機周辺記憶装置に使用される磁気ディスク、磁気ディスクの製造方法、及び磁気記録装置に関する。

【０００２】

【従来の技術】磁気ディスクは、高面記録密度、高データ転送速度、高速アクセス、高信頼性、低価格等の特長を有しており、計算機周辺記憶装置の主流をなしている。過去１０年間に磁気ディスクの面記録密度は数１０倍の伸びを示しており、今後もその面記録密度の向上に期待が持たれている。

【０００３】磁気記録は、磁気ヘッドから発生する信号磁界によって磁気記録層中に記録磁区列を形成して記録を行い、この記録磁区列から記録層外部に漏洩する信号磁界を磁気ヘッドによって再生する事を原理とする。面記録密度を向上する上では、磁気記録層中に形成する記録磁区をいかに微細化できるか、微細な記録磁区から漏洩する微小磁界をいかに高感度に再生できるかがポイントである。

【０００４】記録磁区を微細化する上では、第１に、磁気記録層に最近接する磁気ヘッド先端部を微細化すること、より具体的には、記録（再生）磁気ギャップを狭くすることと、記録（再生）磁極トラック幅を狭くすることにあり、第２に、磁気ヘッド先端部と磁気記録層との間隙（スペーシング）を狭くすること、第３に、磁気ヘッド先端部から空間的に発散する磁界による記録磁区端部のにじみ（フリンジング）を極力低減すること、第４に、磁気ヘッド先端部を磁気記録層の所定の記録再生位置にできるだけ高精度で位置決めすること、が重要である。

【０００５】また、微細記録磁区からの微小磁界を高感度再生する上では再生原理的なブレークスルーが必要とされている。近年、従来の誘導再生原理とは異なる磁気抵抗効果を利用する再生原理が提案され実証されてきており、さらに巨大磁気抵抗効果材料の研究開発が進められていることから、今後の微小磁界再生の主流をなすものとみなされている。

【０００６】上記した記録再生密度の高密度化への技術ポイントは、現行の磁気記録で採用されている長手媒体

を用いたヘッド浮上形の記録再生形態（誘導再生型）でも、垂直媒体を用いたヘッド接触形の記録再生形態（磁気抵抗再生型）でも、共通する事項である。

【０００７】従来からフリンジングを低減化する方策として、狭スペーシング化によるヘッドからのフリンジ磁界の低減と、記録層の磁化転移幅の低減化と、をあげることができる。しかしながら従来の磁気ディスクにおいては、原理的にフリンジングを無くすのは不可能であるため、あるフリンジ値を見込んだ余裕のあるトラック幅とする必要があり、狭トラック化の阻害要因となっている。

【０００８】また、ヘッドの位置決めについては、磁気記録ディスクと磁気ヘッドをドライブに設置した後で、サーボライターを用いて記録層中に磁気的なサーボ信号とアドレス信号を記録し、実動作中にこのサーボ情報を用いて行っているのが現状である。しかしながら、磁気記録層が単純に連続する平坦面である限り、トラッキング精度はヘッドの機械的精度に制限されるので、これも狭トラック化の阻害要因となっている。

【０００９】高精度トラッキング化の一つのアプローチは、特開平２－２０１７３０号公報に開示されるディスクリートトラックである。これは、予め磁気ディスク基板に物理的な凹凸を設けておき、この上に磁気記録層を形成して、凹部からの信号と凸部からの信号の違いを利用してトラックサーボを行うものである。このようなＰＥＲＭ（Pre Embossed Rigid Magnetic）ディスクでは、トラッキング精度は基板に設けられる物理的な凹凸の精度で決定され、凹凸は光ディスク基板プロセスにしたがって設ければ、変動量が０．０１μｍオーダ程度の高精度化を実現することができる。

【００１０】しかしながら、上記のＰＥＲＭディスクにおいてはガードバンドをなす部材が軟質のレジストであるために、レジストのみが選択的に摩耗しやすい。この摩耗を防ぐためにディスク表面を硬質の保護膜で被覆する必要があり、狭スペーシング化しにくいことから、総合的には高精度化技術とは言えない。

【００１１】特開平２－１８９７１５号公報には、基板上にレジストに代表される有機系の厚膜を設けて、それに凹凸状スタンパーを押し当てる等して有機膜上面に物理的な凹凸を設け、凹部中に磁性体薄膜を埋め込み有機膜と磁性体膜が実質的に平坦面をなす磁気記録媒体が開示されている。この磁気記録媒体では磁性体膜の下部は有機膜が存在するために、磁性体膜下部に界面無効層が厚く形成され、所定の特性の磁性体膜を得るには磁性体膜の厚さを厚くせざるをえず、高分解記録が困難であることから、やはり高密度化技術とは言えない。さらに、この従来技術においては記録磁性体膜下部に高透磁率膜を設けることができないので、将来の高密度記録技術として期待されている垂直磁気記録への適用が困難である。

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【００１２】また、特願平５－２０５２５７号公報には、磁気記録層の記録トラック間領域にイオン注入もしくはレーザ照射する等して記録機能を失わせてガードバンドとなす技術が提案されている。しかしながら、この従来技術ではガードバンドに記録層の変質部を使用しているため、均質なガードバンドを形成することが困難であり、また、記録トラックとガードバンドとの境界が不明確になるといった問題点がある。

【００１３】ところで、「磁気抵抗効果」とは、外部磁界により電気抵抗が変化する効果であり、（ａ）再生用の磁性体薄膜の電気抵抗値が電流の向きと再生磁性体の磁化の向きの相対的角度に依存して変化する現象（ＡＭＲ）、（ｂ）非磁性層を介して積層された磁性層間の磁化の相対角度で抵抗が変化する現象（ＧＭＲ）などがある。これは従来の誘導再生に比較すると、再生感度が非常に高く、再生信号強度がヘッド走行速度に依存しないという特長がある。

【００１４】磁気抵抗ヘッドに用いられる磁性体の構造としては、異方性磁気抵抗効果を利用する、例えばＮｉＦｅ単層膜、二つの磁性体薄膜で導電性非磁性膜を挟み込んだスピンバルブ構造、例えばＣｏＦｅ／Ｃｕ／ＣｏＦｅ三層膜、導電性非磁性部材中に磁性粒子を分散させたグラニュラー構造、例えばＮｉＦｅ／Ａｇ、多数の磁性体薄膜と多数の導電性非磁性薄膜を交互に積層した磁性人工格子構造、例えば（Ｃｏ／Ｃｕ）ｎ膜、の４種類が上げられる。

【００１５】これらのうち単層膜構造のものは素子の作成が比較的簡単なことから実用レベルにあるが、抵抗変化率が高々２％程度にすぎないので、今後さらに記録磁区の微細化すなわち再生磁界の微小化が進展する上では、再生感度的に不十分とされている。

【００１６】また、グラニュラー構造と磁性人工格子構造は、数１０％以上の抵抗変化率を呈し、将来的に極めて期待度が高いが、大きな抵抗変化を得る上では数ｋＯｅ～数１０ｋＯｅもの大きな磁界を要するため、微小な媒体磁界の再生は現状では困難とされている。

【００１７】そこで、数百Ｏｅ未満の比較的小さな磁界変化で１０％程度の実用上十分な抵抗変化率を呈するスピンバルブ構造が注目を集め、単層膜構造の次の再生素子として最もその実用化が期待されている。スピンバルブ構造の再生原理は、二つの磁性体薄膜の磁化の相対的な向きによって電気抵抗率が変化するところにあり、実際には一つの磁性体薄膜の磁化の向きを固定しておき、もう一方の磁性体薄膜の磁化の向きを媒体磁界の向きに追随させて二つの磁性体薄膜の磁化の相対的な向き関係を変化させて用いる。片側の磁性体薄膜の磁化の固定のためには、保磁力の高い磁性体膜を磁化固着膜としてこの膜に交換結合し、磁化固定膜とする。もう片側の磁性体薄膜はその磁化が媒体磁界に追随して回転するので、以下これを「磁化回転膜」と略記する。媒体磁界の無い

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状態でのこの磁化回転膜の磁化の向きは磁化固定膜の磁化の向きと直交状態とすることが、再生信号の対称性を確保する上では重要であり、媒体磁界の向きとの関係も含めると、磁化固定膜の磁化方向は媒体磁界と同じ向き、すなわち媒体面に垂直な方向に設定され、一方の磁化回転膜の磁化方向は媒体磁界が無い状態では媒体のトラック幅方向に向いていることが好ましい。

【００１８】上記した磁化固定膜と磁化回転膜の磁化方向の設定には、幾つかの方式が採用されている。磁化固定膜の磁化方向の設定には、磁化固着膜の利用が一般的であり、一方の磁化回転膜の磁化方向の設定には次の２つの方法が提案されている。第１にセンス電流によって発生する磁界を利用する方法があり、第２に磁化回転膜にも適度なバイアス磁界を印加するためのハード膜を交換結合もしくは静磁結合する方法がある。

【００１９】

【発明が解決しようとする課題】しかしながら、前者のセンス電流を用いる方法では、センス電流値が磁化回転膜へのバイアス磁界によって規定されるので、大電流化による大出力化が図れないこと、磁化回転膜へのバイアス磁界は磁化固定膜に対してはその磁化方向を逆転させる向きに作用するので、動作上の信頼性が確保しにくいこと等の問題点がある。

【００２０】一方、後者のハード膜バイアスを用いる方法では、ヘッドの膜構造が複雑化して製造プロセス工程数が増加し、安価にヘッドを提供することが困難であること等の問題点がある。

【００２１】以上、磁気抵抗効果素子を使用する際のバイアスの重要性と具体的な手段について、スピンバルブ構造の例をとって説明したが、他のいずれの構造の磁気抵抗効果膜を使用する場合においても、実用上は磁化の回転を媒体磁界の向きに対して対称にすることが、波形歪みを防止する上で必要であり、磁気抵抗効果膜に対して何等かの手段で磁界をバイアスさせて用いる。

【００２２】本発明の目的は、記録磁区のサイドフリンジを低減することができ、磁気ヘッドの位置決め精度を狭スペーシング時にも向上させることができる磁気ディスク及びその製造方法を提供することにある。

【００２３】また、本発明の目的は、記録磁性体膜の膜厚を高分解能記録可能な膜厚に設定することができ、将来の垂直磁気記録もしくは接触記録にも適用することができ、とくに磁気抵抗効果型記録ヘッドに適する高密度記録可能な磁気ディスク及びその製造方法を提供することにある。

【００２４】さらに、本発明の目的は、磁気抵抗効果型記録再生ヘッドに大きなセンス電流を流すことができ、ヘッドの動作信頼性を確保することができ、かつ安価にヘッドを製造できる磁気ディスク及びその製造方法を提供することにある。

【００２５】さらに、本発明の目的は、サイドフリンジ

が少なく、かつトラッキングサーボ特性の安定した狭スペーシング記録または接触記録の動作を可能とする磁気ディスク及びその製造方法を提供することにある。

【００２６】さらに、本発明の目的は、大容量で高密度記録可能な磁気記録装置を提供することにある。

【００２７】本発明に係る磁気ディスクは、基板と、この基板上に設けられ、情報を磁気的に記録再生する磁性部材でつくられた記録トラック部と、互いに隣接する前記記録トラック部間にトラック方向に実質的に連続するように設けられ、前記磁性部材よりも硬く、かつ非磁性の材料でつくられたガードバンド部材と、を具備し、上記ガードバンド部材の下方領域には、上記磁性部材が存在しないか、又は、上記記録トラック部をなす磁性部材の厚みとは異なる厚みの磁性部材が設けられていることを特徴とする。

【００２８】本発明に係る磁気ディスクの製造方法は、（ａ）実質的に平坦な表面をもつ基板上に磁性材料からなる磁性層を形成する工程と、（ｂ）この磁性層の一部を除去してトラック方向に実質的に連続するように互いに隣接する記録トラック部を規定するガードバンドスペースをパターン形成する工程と、（ｃ）このガードバンドスペースを、前記磁性層をなす磁性材料よりも硬く、かつ非磁性の材料からなるガードバンド部材で満たす工程と、（ｄ）このガードバンド部材及び前記磁性層の表面がそれぞれ実質的に平坦になるように加工する工程と、を備えることを特徴とする。

【００２９】上記ガードバンド部材は、ディスク表面にあらわれてさえいればよく、その厚みは磁性部材の厚みと同じであってもよいし、これより厚くてもよいし、これより薄くてもよい。

【００３０】また、ガードバンド部材は、非磁性の硬質材料でできていることが望ましく、SiO_2，Al_2O_3，TiO_2のような酸化物、Si_3N_4，ＡｌＮ，ＴｉＮのような窒化物、ＴｉＣのような炭化物、ＢＮのような硼化物、あるいはＣ系，ＣＨ系，ＣＦ系のうちいずれかの重合化合物でできていることが好ましい。ガードバンド部材が非磁性であるため、サイドフリンジの問題はほぼ完全に解決される。また、ガードバンド部材が磁性部材より硬質であるため、コンタクトスタートストップ（ＣＳＳ）耐性に優れ、さらには将来の接触記録方式においても耐久性に優れたものとなる。

【００３１】本発明の磁気ディスクにおいては、磁性部材そのものは微細な凹凸状の物理的な形状変化をなしている。この磁性部材の凹部に、ガードバンド部材が磁性部材の凸部表面まで埋め込まれ、ディスク表面が実質的に平坦面をなすことが望ましい。磁性部材の凹凸形状は重要であり、サイドフリンジングを低減し、かつ高精度のトラッキングを行なう上では、記録トラック方向に実質的に連続して設けられることが好ましい。ガードバンド部材がこのような形態を採ることで、サイドフリンジングの問題は本質的に解決できると同時に、光ディスクに類似の高精度トラッキングが可能となる。

【００３２】ここで、「実質的に連続」の意味は、ガードバンド部材は必ずしもトラック一周に亘って連続している必要は無いが、記録磁区列形成部分もしくは必要があれば設けられる磁気的サーボ情報記録部分に亘ってトラック方向に連続してさえいればよい。より好ましい凹凸形状は、前記したトラック方向に実質的に連続する形状に加えて、トラック方向に略連続する形状以外に必要があれば設けられるアドレス信号が記録磁性層の形状変化として情報記録されている形態である。このような形態を採れば、従来から実施されているサーボライティングの必要性は全く無くなる。

【００３３】また、高密度記録上重要な本発明の効果として、記録分解能の向上すなわち線記録密度の向上もあげることができる。これは記録磁性部材を非磁性ガードバンド部材で記録トラック部ごとに分離することによって、磁性部材の形状磁気異方性が記録トラック方向に付与され、磁化転移部における再生信号の揺らぎが小さくなることによっている。

【００３４】記録磁性部材の凹凸部に埋め込まれているガードバンド部材と磁性部材面を実質的に平坦面とすれば、記録層の上に耐摩耗性保護層を設けなくてもよくなる。そのような場合はスペーシング損失を低減する上では最も好ましい形態である。磁気ヘッドをディスクの記録面に接触走行させる場合は、ガードバンド部材は磁気ヘッドを案内するガイドレールの役割をもつ。なお、接触記録方式では記録磁性部材が露出していると十分な信頼性が得られない場合には、保護層を設けてもよい。保護層はガードバンド部材と同じ材質からなる硬質非磁性部材であることが望ましい。

【００３５】さらに、ガードバンド部材の電気抵抗は、磁性部材の電気抵抗よりも大きいほうが望ましい。磁気抵抗効果方式の記録再生を考慮する場合に、ガードバンド部材は記録磁性部材に比べて電気的に絶縁性を有することが好ましく、比抵抗値として少なくとも記録磁性部材よりも一桁程度高い値をもつことが好ましい。このようにすれば、横通電方式の磁気抵抗ヘッドを用いて接触再生させた場合においても、電流が媒体に漏洩して再生出力を低下させてしまうといった問題をも解決することができる。

【００３６】磁性部材としては、通常の磁気ディスクに用いられているＣｏ系材料、例えばＣｏＮｉＰｔ，ＣｏＰｔ，ＣｏＰｔＣｒ，ＣｏＴａＣｒ，ＣｏＮｉＣｒ，将来の垂直磁気記録材料として期待されているＣｏＣｒ，ＣｏＰｔＯ，それ自体が硬質であることから接触記録材料として研究されているＢａフェライト系、Ｆｅ系もしくはＣｏ系粒子を硬質マトリクス中に分散させた材料系等を用いることができる。

【００３７】なお、記録磁性部材の下地には基板が直接

配置されてもよいが、好ましくは面内媒体に対しては配向制御膜としてＮｉＰ，Ｃｒ等、垂直媒体に対しては閉磁路形成膜として高透磁率膜、例えばＮｉＦｅ膜等が形成されているのがよい。基板の材料は特に限定されないが、通常はアルミニウムやガラスを用いる。さらに、耐薬品性に優れるガラス基板を用いることが好ましい。

【００３８】本発明に係る磁気ディスクは、基板と、この基板上に設けられ情報を磁気的に記録再生する磁性部材でつくられた記録トラック部と、互いに隣接する前記記録トラック部間にトラック方向に実質的に連続するように設けられ、上記記録トラック部をなす磁性部材とは磁気的に異なる材料でつくられ、外部に直流磁界を供給する磁石部材と、を備えることを特徴とする。

【００３９】本発明に係る磁気ディスクの製造方法は、（Ａ）実質的に平坦な表面をもつ基板上に磁性材料からなる磁性層を形成する工程と、（Ｂ）この磁性層の一部を除去してトラック方向に実質的に連続するように互いに隣接する記録トラック部を規定するスペースをパターン形成する工程と、（Ｃ）このスペースを、前記磁性材料とは磁気的に異なる材料でつくられ、外部に直流磁界を供給する磁石部材で満たす工程と、（Ｄ）この磁石部材及び前記磁性層の表面がそれぞれ実質的に平坦になるように加工する工程と、を備えることを特徴とする。

【００４０】「トラック方向に実質的に連続する」とは、少なくとも情報信号の記録／再生部分に磁石部材が存在していればよいことを意味する。したがって、アドレス情報領域およびサーボ情報領域には磁石部材は有っても無くてもよく任意のものである。

【００４１】また、アドレス情報やサーボ情報を磁石部材パターンによって設けてもよく、このような場合はこの部分の磁石部材はトラック方向に実質的に連続していなくとも構わない。

【００４２】磁石部材から外部（ヘッド方向）に発生する直流磁界は媒体面に平行な記録トラックに平行な方向とするのが一般的であるが、縦通電方式の磁気抵抗再生素子を用いる場合は媒体面に垂直に発生させるのがよい。

【００４３】さらに、磁気ディスクは、必要に応じて下地層、保護層、潤滑層等を備えてもよい。

【００４４】磁性部材には、Ｃｏ－Ｐ、Ｃｏ－Ｎｉ－Ｐメッキ膜、Ｃｏ－Ｎｉ蒸着膜、Ｂａフェライトスパッタ膜、Ｃｏ－Ｐｔ、Ｃｏ－Ｃｒ、Ｃｏ－Ｎｉ－Ｃｒ、Ｃｏ－Ｃｒ－Ｔａ、Ｃｏ－Ｎｉ－ＰｔのＣｏ系スパッタ膜を用いることが望ましい。

【００４５】磁石部材は、磁気ヘッドの記録媒体によって磁化方向が変化しない程度に大きな保磁力を持つ材料であればどのような材質のものであってもよい。発生磁界の大きさも重要であるが、これは磁石部材の磁化の値（材料特性と製造方法に依存する値）以外に磁石部材のサイズ（幅と膜厚）や、磁石部材の下地に軟磁性膜を設

けることによっても調整可能である。例えば、磁石部材としてフェライト系、ＳｍＣｏ系、ＮｄＦｅＢ系等のバルク磁石材料を薄膜化して用いてもよく、Ｐｔ／Ｃｏ多層膜系、ＭｎＢｉ系、ＴｂＣｏ系、ＴｂＦｅＣｏ系等の主に光磁気記録媒体に使用されるような高保磁力薄膜材料を用いてもよい。

【００４６】本発明に係る磁気記録装置は、基板と、この基板上に設けられ、情報を磁気的に記録再生する磁性部材でつくられた記録トラック部と、互いに隣接する前記記録トラック部間にトラック方向に実質的に連続するように設けられ、前記磁性部材よりも硬く、かつ非磁性の材料でつくられたガードバンド部材と、を具備し、上記ガードバンド部材の下方領域には、上記磁性部材が存在しないか、又は、上記記録トラック部をなす磁性部材の厚みとは異なる厚みの磁性部材が設けられている磁気ディスクに対して、情報を磁気的に読み込み書き込む磁気ヘッドと、外部装置から送られてくる書き込み情報をデータ処理し、データ処理された情報をリードライト回路を介して前記磁気ヘッドに送る制御部と、を備え、上記磁気ヘッドはスピンバルブ型の磁気抵抗素子を具備し、このスピンバルブ型の磁気抵抗素子は、上記リードライト回路に接続され、上記磁気ディスクの面に垂直方向に磁化が固定された第１の磁性層と、磁化が印加磁界により変化する第２の磁性層と、この第２の磁性層と上記第１の磁性層との間に挿入された非磁性導電層と、を備えていることを特徴とする。

【００４７】

【発明の実施の形態】以下、添付の図面を参照しながら本発明の種々の実施の形態について説明する。

【００４８】図１は本発明の実施例に係る磁気ディスクの一部を示す拡大斜視図である。図中にて符号１ａは基板を、符号２は記録層を表わす。記録層２は、記録トラック方向に長い帯状をなす記録磁性部材２ａと、記録磁性部材２ａの間に埋め込まれた記録磁性部材２ａとは異なる材料からなるガードバンド部材４ａと、を含んでいる。このように記録層２においては、磁性部材２ａとガードバンド部材４ａとがディスク半径方向にトラックピッチを１周期として周期的に交互に配列されている。

【００４９】帯状の記録磁性部材２ａの幅すなわち記録トラック幅をＴとし、帯状のガードバンド部材４ａの幅すなわちガードバンド幅をＧとし、記録磁区の長さをＢとすると、トラックピッチは（Ｔ＋Ｇ）で与えられ、面密度の逆数に相当する実効的な記録磁区面積は（Ｔ＋Ｇ）×Ｂで与えられる。本実施例においては、ディスク基板１ａとしては２．５インチサイズのものを用い、記録トラック幅Ｔを１．８±０．１μｍ、ガードバンド幅Ｇを０．２±０．１μｍとした。これらは、記録セルのアスペクト比（トラックピッチ／最短ビットピッチ）を現行の磁気記録ディスク同様に１０とし、ディスクへの記録としてゾーンコンタクトアンギュラーヴェロシティ

（ＺＣＡＶ）方式を採用するとした場合、面記録密度は１．５Ｇｂｐｓｉ程度、ディスク２枚４面のドライブでは記憶容量が１．５ＧＢ、となるトラックピッチに相当する。

【００５０】次に、図２～図６を参照しながら磁気ディスクの製造方法について説明する。洗浄済みのガラスディスク基板１ａを、多元マグネトロンスパッタ装置の処理台上に載置し、ＣｏＰｔ（２０原子％Ｐｔ）ターゲットを約１分間スパッタして膜厚が約２０ｎｍの面内磁化の記録磁気層２ａを形成した。さらに連続してSiO_2ターゲットを１分間スパッタして膜厚約１０ｎｍのSiO_2膜を形成して取り出した。

【００５１】次に、この着膜後のディスクのSiO_2膜上にポジ形レジスト３を約５０ｎｍスピンコートしてプリベークした後に、Ｋｒレーザを光源とする光ディスク用の原盤カッティング装置を用いて、ディスク１を高精度で回転させながら、トラックピッチ２μｍ、露光幅０．２μｍ（ガードバンド部４ａの幅G_1，G_2，G_3，…Ｇｎ）でレジスト３を露光処理した。なお、ディスク全面の露光に要する時間は約１０分間とした。現像処理に供して記録層２ａ上に同心円状のレジストパターンを形成した。ＦＩＧ２に示すように、記録層２の記録トラック部２ａはSiO_2膜を介してレジスト被覆され、ガードバンド部４ａに相当する部分はSiO_2膜のみで被覆されレジストは無い状態にあった。

【００５２】次に、このレジストパターンを有するディスク１をＲＩＥ装置内に装入し、CHF_3ガスを用いてSiO_2膜を約３０秒間だけ反応性イオンエッチングした。ガードバンド部４ａの記録層２ａを露出させた後に、ディスクをレジストアッシング装置内に装入し、記録トラック部２ａ上のレジストパターンを除去した。

【００５３】次に、SiO_2膜パターンを有するディスクをＲＩＥ装置内に装入し、ディスクを約２００℃に加熱して、塩素と三塩化硼素を主成分とする混合ガスプラズマを用いてＣｏＰｔ膜を約１分間だけ反応性イオンエッチングした。下地の基板面までエッチング除去することにより、ＦＩＧ３に示すように、隣り合うＣｏＰｔ記録層２ａの相互間に帯状のガードバンドスペースを形成した。さらに、ＦＩＧ４に示すように、アッシング装置によりレジスト３を除去した。

【００５４】次に、ガードバンドスペースをもつディスクをスパッタ装置内に装入し、ガードバンドスペースが完全に埋まるまで約２分間スパッタし、ＦＩＧ５に示すように、ディスク表面をSiO_2膜で覆った。これを取り出してイオンポリッシング装置内に装入し、記録磁性部材２ａの上面が露出するまで約３０秒間ディスク面を研磨した。これにより同時に記録層上に凹凸面をなしていたSiO_2膜４を平坦化する。その結果、ＦＩＧ６に示すように、帯状の記録磁性部材２ａ及びガードバンド部材４ａが交互に表面にあらわれたディスク１が得られた。

【００５５】得られたディスク１の一部を破壊し、その断面構造を電子顕微鏡で観察したところ、図１に示すように、記録磁性部材２ａとガードバンド部材４ａとは段差の無い実質的に平滑な表面をもつことが確認された。

【００５６】なお、本実施例におけるトータルプロセス時間の増分は生産設備増強によって十分に補い得る程度であり、ディスクコストの上昇は微々たる程度に抑えることができる。

【００５７】また、上記実施例では磁性膜のパターニングに反応性イオンエッチングを用いた場合につき説明したが、イオンミリング法を用いることもできる。その場合は磁性膜上にSiO_2を設ける必要はなく、直接レジストをコートしてレーザ露光した後に、磁性膜をイオンミリングによりパターニングしてレジストを除去し、SiO_2を埋め込みイオンポリッシュすればよい。ただし、加工精度は反応性イオンエッチングの方が優れていた。

【００５８】磁性膜をパターニングする際のマスクあるいはガードバンドを成す材料にはSiO_2以外に適当に記録磁性以外の材料を自由に用いることができるが、好ましくは記録磁性部材よりも硬質で絶縁性の良好な材料がよい。製造プロセス上は特に材料に限定されず、例えば、マスクにＣを用いる場合は酸素ベースガスでマスクパターニングすることができる。

【００５９】上記した製造方法によって試作した本発明の磁気ディスクを用いて以下の手順で本発明の効果を明らかにする実証試験を実施した。また、以下に記述する実証試験においては本発明の効果を明確化する目的で従来技術に従って磁気記録ディスクを作成して同時に評価した。この従来の磁気記録ディスクは、上記実施例において、ガラス基板上にＣｏＰｔ磁性層をスパッタ形成した段階で取り出したもの（以降、比較ディスクＡと略記する）と、２０ｎｍのＣｏＰｔ記録層と１０ｎｍのSiO_2層（従来技術においては保護層として機能する）をスパッタした段階で取り出したもの（以降、比較ディスクＢと略記する）の２種類である。

【００６０】以下、本発明の実施例に係るディスク（以下、実施例ディスクＣという）と、比較ディスクＡ及びＢとについて試験した結果について説明する。

【００６１】先ず、得られたディスクサンプルと各々同一条件で作成した試料につきバイブレイティングサンプルマグネトメーター（以下、ＶＳＭという）を用いて静的磁気特性を測定した。本発明のディスク試料は記録層中に記録磁性部材の他に非磁性部材を具備しているので、断面電子顕微鏡観察結果に基づき、正味の磁性部材の体積を求めて磁化の大きさを決定した。

【００６２】ＶＳＭ測定を図１に示した膜面内平面の記録トラックに平行な方向と垂直な方向の二通りで測定した結果、比較ディスクＡ及びＢではトラック平行方向と

垂直方向でＶＳＭループに有意差は見られなかったが、実施例ディスクＣでは、記録層の磁性部材の磁化がトラックと平行に容易軸を有しているようであった。これは、記録トラックに平行に磁性部材が形状異方性を有したためと考えられ、磁気記録上は好ましいことであるとみなせる。

【００６３】飽和磁化の大きさは、実施例ディスクＣ、比較ディスクＡ，Ｂともに約６５０ｅｍｕ／ｃｃと有意差は見られなかった。

【００６４】保磁力は、比較ディスクＡとＢとの間では有意差は無く、２ｋＯｅ程度であったが、実施例ディスクＣでは測定方向で値が異なり、トラック平行方向に磁界を印加した場合が２．５ｋＯｅ、トラックと垂直方向に磁界を印加した場合が１．５ｋＯｅと、形状異方性を反映する値を示した。磁気記録の高密度化上は高保磁力であることが重要であるが、記録磁区は、記録トラック方向に配列するので本発明の磁気記録ディスクの構造は高密度化上、記録波長を短くする上でも静的磁気特性の観点から効果的であることが判明した。

【００６５】次に、実施例と比較用の２．５インチディスク（ルブリカントは塗布した）を磁気ディスク試験装置に設置してトラッキングサーボ精度の比較評価と記録再生動作を行った。磁気ヘッドは本発明の狭トラック動作が可能なように特別に試作した横通電磁気抵抗効果再生型の薄膜ヘッドを用いた。本発明の効果を明確にする上で、磁気ヘッドのトラック幅は記録再生ともに２μｍとし、定格回転動作における浮上量を実施例ディスクＣと比較ディスクＡでは０．０４μｍとし、比較ディスクＢでは０．０３μｍとし、どのディスクでもヘッドーメディアスペーシングが０．０４μｍになるようにした。また、ディスク上の任意の半径に磁気ヘッドを位置合わせし、適当な信号を記録して機械的なトラックずれに対して再生信号が最大になるようにトラッキングする制御系を用いた。

【００６６】先ず、トラッキング性能試験の結果を記述する。実施例ディスクＣと比較ディスクＡ，Ｂともに適当な信号を記録した後のトラッキング特性はほぼ一致した。次に隣接するトラックには記録せずにその次のトラックに信号の記録を行い、記録しなかったトラックにヘッドを送ってディスクの回転を継続したところ、磁気記録信号のみからトラッキング信号を得る比較用のディスクはスピンドルモータの機械的回転精度が不足することに起因して次第にトラックのずれを発生し、隣接トラックの記録信号を次第に再生するようになったのに対して、本発明の磁気ディスクは未記録状態のトラックでもガードバンド部とは磁気信号出力が全く異なるため、トラッキングずれの発生は皆無であった。従って、本発明の磁気ディスクでは実際のドライブで駆動する場合にとくにトラッキングサーボ信号を予め記入する必要は無く、フォーマット効率が向上してユーザデータ容量が増

加する他、アドレス信号もディスク作成時の磁性膜パターニング時に記入可能なので、サーボライティングの必要が無いことが明らかである。

【００６７】次に、図１に示すような狭トラックピッチの記録を行った場合のサイドフリンジ特性をオフトラック再生動作とオーバーライト動作とによって評価した。用いた磁気ヘッドは前記したトラッキング評価に用いたものと同一である。先ず、適当な位置のトラックに信号記録を行った後にトラッキング信号にオフセットをかけながら少しずつオフトラックをかけ、オフトラック量と再生信号強度の関係を測定した。その結果、比較ディスクＡ，Ｂではヘッドトラック幅の両側にマグネティックフォースマイクロスコープ（以下、ＭＦＭという）で観察して０．２μｍ程度ずつのサイドフリンジを発生したために、２．２μｍ程度オフトラックしないと信号出力が零レベルに定価しなかったのに対して、本発明のディスクではＭＦＭ観察では全くサイドフリンジの発生は無く、２μｍのオフトラック即ち隣接トラック上では信号出力は零レベルに低下した。

【００６８】さらに、隣接し合う３本のトラックに同一周波数で信号記録を行い、次に真中のトラックに１．５倍の周波数の信号を記録してオーバライト特性とクロストーク特性を調べた結果、比較ディスクＡ，Ｂでは隣接トラックの信号を拾うと共に十分なオーバライト特性が得にくかったのに対して、本発明のディスクでは隣接トラック信号は全く無く十分なオーバライト特性が得られた。従って実施例ディスクＣは狭トラック化に対して大きな効果を有することが実証された。

【００６９】次に、本発明のさらなる効果の一つを明らかにする目的で、実施例ディスクＣ、比較ディスクＡ及びＢの三種類のディスクをコンタクトスタートストップ試験（以下、ＣＳＳ試験という）に供して、その耐摩耗性を調べた。ＣＳＳ試験はディスクの回転起動から定格回転に至るまでの時間（起動時間）を調べることと、５万パス試験後のディスク表面状態を遮光観察して調べた。平坦な磁性膜上に保護膜を有していないルブリカントのみの比較ディスクＡでは数百パス程度で起動時間が数１０秒という異常な値を示し、従来構造の保護膜とルブリカントの両方を有する比較ディスクＢは５万パス後も起動時間は２．５秒程度と正常値を維持した。これらに対して本発明の磁性膜上には保護膜を有さないがSiO_2 ガードバンドを有する実施例ディスクＣでは比較ディスクＢと同様の結果が得られ、遮光観察の結果も特に摩耗は認められなかった。これにより実施例ディスクＣは保護膜無しでもヘッドが硬質ガードバンド部材によって案内されながら走行するので保護膜有りの場合と同様の強い耐摩耗性を示すことが実証でき、狭いスペーシング化する上でも有利であることが確認された。

【００７０】さらに、磁気抵抗効果再生ヘッド再生での優位性を実証する目的で再生ヘッドに通電した状態でヘ

ッド荷重を増加させてヘッドを媒体面に接触させて走行試験を行った。比較ディスクＡでは接触させた瞬間に再生信号強度は半分以下に低下した。これは導電性の記録層に電流が分流したためである。

【００７１】また、比較用のディスクＢでは接触走行させても再生信号の低下は見られなかったが、接触動作を連続的に行う試験を何回か行ったところ、突然信号が出なくなる場合があった。信号が出なくなった磁気ヘッドを調べてみると絶縁破壊に至っていることが明らかとなった。これはディスクの保護膜が絶縁性であるために回転動作で静電気が蓄積し、それがヘッドに集中して放電を起こしたためと考えられる。

【００７２】一方、実施例ディスクＣでは接触走行時の再生信号強度は浮上時よりも１０％程度低下したものの、連続して接触再生試験を行っても全く絶縁破壊は発生しなかった。信号の低下が比較ディスクＡに比べて僅かなのは導電性の記録層が絶縁性のガードバンドで隔絶されているためであり、絶縁破壊が発生しないのはディスク面が完全に絶縁性の保護膜で覆われていないためと考えられる。

【００７３】上記の実施例では記録磁性材料としてＣｏＰｔを用い、特に下地層を設けない場合についてのべたが、本発明は記録材料の種類や下地の有無には特に限定を受けず、記録材料としてＣｏＮｉＰｔ，ＣｏＣｒＰｔ，ＣｏＴａＣｒ，ＣｏＮｉＣｒ，垂直磁化のＣｏＣｒ等を自由に用いることができる。また、下地にＮｉＰメッキ層やＣｒ配向制御層あるいはＮｉＦｅ軟磁性層等が設けられていても実施可能である。

【００７４】さらに、ガードバンド部材は図１及び図６に示したもののみに限られない。図７に示すように、横断面Ｖ字状のガードバンド部材４ｂを磁性部材２ａの膜厚の途中まで設けてもよい。このようなガードバンド部材４ｂは、磁性部材２ａの結晶配向を所定方向に制御するとともに、特殊なエッチング法を用いることにより形成される。なお、ガードバンド部材４ｂは横断面Ｖ字状の他に横断面長円形状であってもよい。

【００７５】また、図８に示すように、横断面矩形状のガードバンド部材４ｃを磁性部材２ｃの下方の下地層５と基板１の境界まで設けてもよい。下地層５を有する媒体に対してもこのようなガードバンド部材４ｃを形成することができ、高密度の記録再生を実現できる。

【００７６】さらに、図９に示すように、横断面長円形状のガードバンド部材４ｄを基板１ａの一部に入り込むように形成してもよい。下地層の無い媒体１において基板１ａの途中までこのようなガードバンド部材４ｄを形成することができ、高密度の記録再生を実現できる。

【００７７】本発明によれば、硬質ガードバンド部材により記録磁性部材を互いに分離することで、サイドフリンジが大幅に低減化され、狭トラック化が容易となる。また、保護膜が無くても高耐久性を達成でき、狭スペーシング化が容易となり、かつ狭ビットピッチ化が容易となり、総合的に磁気記録の高密度化に貢献する所多大である。さらに、高価格化を招くことなく、硬質ガードバンド部材の形成が可能な磁気ディスク及びその製造方法が提供される。

【００７８】また、本発明によれば、記録層下部に配置する膜に対する自由度が高く、面内媒体の場合は配向制御膜を配置する等して記録磁性厚を高密度記録対応の薄さに設定するのが簡単になり、垂直媒体では記録層下部に高透磁率層を配置する等して記録再生磁界を強めることが容易になる。また、硬質のガードバンド部材を採用することによりＣＳＳ耐性を大幅に向上することができるので、将来的には接触記録方式に対しても十分に応用できる。さらに、絶縁性のガードバンド部材を採用すれば磁気抵抗効果型ヘッドをディスク面に接触させることも可能であり、総合的に磁気記録の高密度化に大いに寄与する。

【００７９】次に、図１０～図１３を参照しながら磁気記録装置及び磁気ヘッドについて説明する。

【００８０】図１０に示すように、磁気記録装置２０のターンテーブル上にディスク１が載置され、スピンドルモータ２１によってディスク１がスピン回転されるようになっている。磁気ヘッド２２はアーム２８の先端部に設けられている。アーム２８の基端部はボイスコイルモータ（ＶＣＭ）２９によって支持されている。

【００８１】図１１に示すように、マイクロプロセッサ３５は、スピンドルドライバ３１、ＶＣＭドライバ３９、ハードディスクドライブ（ＨＤＤ）コントローラ３３のそれぞれに接続され、これらに制御信号を送るようになっている。このマイクロプロセサ３５はサーボ制御とデータ処理の両方を実行するものである。例えばマイクロプロセサ３５は、ＶＣＭ２９の動作を制御するために毎秒３０００回のサンプリングを行なう一方で、サーボ制御のためのディジタル信号を生成する。このディジタル信号をＤ／Ａ変換してＶＣＭドライバ３９の制御に使用する。これによりアーム２８のアクチュエータとしてのＶＣＭ２９を駆動制御し、磁気ヘッド２２をディスク１の記録面の所望箇所に近接又は接触させる。また、マイクロプロセッサ３５は、ディスク１が所望速度で回転するように、モータ２１及びスピンドルドライバ３１を制御する。

【００８２】さらに、書き込み／読み出しの処理もマイクロプロセッサ３５の監視のもとで実行されるようになっている。すなわち、マイクロプロセッサ３５は、ＨＤＤコントローラ３３と信号をやりとりし、ディスク１に記録すべきデータを信号化し、これをリードライト回路３２を介して磁気ヘッド２２に送る。一方、ＨＤＤコントローラ３３はホストインターフェース３４を介して外部のホストコンピュータ（図示せず）に接続されている。ディスク１に記録すべきデータはホストコンピュー

タからＨＤＤコントローラ３３に入力され、この入力データがマイクロプロセッサ３５にいったん送られ、マイクロプロセッサ３５でデータ処理され、さらにこれがＨＤＤコントローラ３３にもどされる。なお、アーム２８に複数のヘッドが搭載されている場合には、マイクロプロセッサ３５はこれらの多重化処理を実行する。

【００８３】次に、図１２，１３を参照しながら磁気ヘッドについて説明する。

【００８４】図１２は磁気ヘッドユニット２２の原理的構成を模式的に示した図である。磁気ヘッドユニット２２には記録ヘッド２３および再生ヘッド２４が搭載されている。記録ヘッド２３は通常用いられているような記録磁極にコイルが巻回された機構を備える薄膜タイプの誘導型ヘッドである。この記録ヘッド２３は、端子２５を介して記録アンプ（図示せず）からデータ信号に応じた記録電流が供給されることによって、磁気ディスク１上にデータ信号を記録するものである。

【００８５】再生ヘッド２４はスピンバルブ型磁気抵抗素子（ＭＲ素子）を用いた巨大磁気抵抗効果型ヘッド（ＧＭＲヘッド）である。この再生ヘッド２４は磁気ディスク１上に記録されたデータ信号や、データ信号の記録に先立ち予め記録されたサーボ信号の再生を行う。再生ヘッド２４のＭＲ素子には端子２６を介してセンス回路（図示せず）からセンス電流が供給されるようになっている。また、磁気ディスク１上に記録された信号に基づく磁界によるＭＲ素子の磁気抵抗の変化がセンス電流による電圧変化、すなわち電圧信号として端子２６より取り出され、この電圧信号が再生アンプ（図示せず）に供給されるようになっている。

【００８６】図１３に示すように、記録ヘッド２３のスピンバルブ型ＭＲ素子は、ピン層（第１の磁性層）２３ａ、フリー層（第２の磁性層）２３ｂ、非磁性導電層２３ｃ、並びに１対のリード２３ｄを備えている。ピン層２３ａは磁気ディスク１の面に垂直方向に磁化が固定されている。フリー層２３ｂは磁化が印加磁界により変化する。非磁性導電層２３ｃはピン層２３ａとフリー層２３ｂとの間に挿入されている。１対のリード２３ｄはピン層２３ａのトラック幅方向両端部に接続されている。各リード２３ｄには端子２５がそれぞれ接続されている。各端子２５はリードライト回路３２に接続されている。

【００８７】ピン層２３ａおよびフリー層２３ｂは例えばＣｏ－Ｆｅ膜からなり、非磁性導電層２３ｃは例えばＣｕ膜からなる。ここで、フリー層２３ａはトラック幅方向に磁気ディスク面と並行に磁化が揃うように配向されている。信号磁界を記録ヘッド２３のＭＲ素子に印加すると、フリー層２３ｂの磁化方向が決まり、このフリー層２３ｂの磁化方向とピン層２３ａの磁化方向との関係で、１対のリード２３ｄ間で見たＭＲ素子の電気抵抗が変化する。この電気抵抗の変化現象が巨大磁気抵抗効果である。

【００８８】次に、図１４～図１９を参照しながら本発明の他の好ましい実施の形態について説明する。

【００８９】図１４にて符号１ａは基板、符号２は記録層、符号１１は磁石部材、符号１２は記録磁性部材をそれぞれ示す。本実施形態では記録磁性部材１２として２０ｎｍ厚のＣｏＰｔ膜を、磁石部材１１として２０ｎｍ厚のＴｂＣｏ膜を、基板１ａとして２．５インチ径のガラス基板を各々用いた。

【００９０】記録層２は磁石部材１１と記録磁性部材１２とをディスク半径方向に交互に備えている。記録磁性部材１２は記録トラックＴ１，Ｔ２，…Ｔｎをそれぞれ形成し、磁石部材１１は直流磁界を発生する記録トラック間領域Ｍ１，Ｍ２，…Ｍｎをそれぞれ形成している。記録磁性部材１２の磁化の向きは、長手記録媒体の場合は記録トラックに平行であり、垂直記録媒体の場合は膜面に垂直である。

【００９１】一方、磁石部材１１の磁化の向きは、横通電方式の磁気抵抗ヘッドで動作させる場合は膜面に垂直であり、縦通電方式の磁気抵抗ヘッドで動作させる場合は膜面内で記録トラックＴ１，Ｔ２，…Ｔｎに垂直である。なお、横通電方式であっても縦通電方式であっても磁石部材１１の磁化の向きは１トラック毎に逆向きに設定するのがよい。

【００９２】図１４に示す磁気ディスク１Ｄは、例えば以下の方法で製造することができる。　平坦面を成すガラス基板１ａ上に先ず平坦なＣｏＰｔ膜をスパッタリングによって形成し、連続してSiO_2膜を１０ｎｍの膜厚まで形成する。次いで、SiO_2膜上にレジストをスピンコートし、光ディスクの原盤カッティングに使用されるレーザ露光装置を使用してコンセントリックにレジストの露光を行い、現像処理してレジストのパターニングを行う。

【００９３】次に、ＲＩＥ装置内に基板１を装入し、例えばCHF_3ガスを用いてSiO_2膜をエッチングする。さらに、アッシングによりレジストパターンを除去し、ＣｏＰｔ膜上にSiO_2パターンを形成する。次いでＲＩＥ装置により例えば塩素を三塩化硼素の混合ガスを用いてＣｏＰｔ磁性膜を基板面に至るまでエッチングする。

【００９４】さらに、スパッタ装置を用いて磁気的に補償組成（Ｔｂ；２２原子％程度）付近の高保磁力（１０ｋＯｅ程度）のＴｂＣｏ垂直磁化膜を２０ｎｍの膜厚まで形成し、その後イオンポリッシング装置を用いて記録磁性部材１２上に形成された余分なＴｂＣｏ膜を除去し、磁気ディスク１Ｄを得た。

【００９５】磁石部材１１として用いたＴｂＣｏ膜は非晶質合金で記録磁性部材１２に用いたＣｏＰｔ膜よりも高硬度であるので、このまま保護膜を特に形成することなくディスク評価に供した。

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【００９６】ところで、得られたディスクを評価に供する前に磁石部材（磁石層）１１の初期磁化方向を設定する必要がある。これはエアースピンドルモータを備えた高精度位置決め可能な光磁気記録装置を用いて行なった。先ず、光磁気記録装置にディスク１Ｄを設置する。そして、膜面に対して垂直に記録磁界を印加して１トラック毎に記録磁界の向きを上下反転させながら、ＴｂＣｏ膜１１に半導体レーザ光を集光照射して膜の磁化を上向きもしくは下向きに１トラックに亘り一様に整え、２μｍのトラックピッチで光ヘッドをディスク半径方向にコンセントリックに送った。このようにして磁石層１１の磁化方向が設定されたディスク１Ｄを磁気記録再生試験装置内に設置して評価した。

【００９７】図１５は磁気ディスク１Ｄの評価試験に用いた磁気抵抗再生型磁気ヘッドを再生部のＡＢＳ面から見込んで示す模式図である。図１５に示す磁気ヘッドは本実施形態の磁気ディスク１Ｄを評価するために特別に試作したものである。図中にて符号４１は磁化回転膜、符号４２は磁化固定膜、符号７は導電性非磁性膜、符号８は磁化固着膜、符号６は電極膜をそれぞれ表わす。

【００９８】磁化回転膜４１および磁化固定膜４２にはＣｏＦｅ膜を、導電性非磁性膜７にはＣｕを、磁化固着膜８にはＦｅＭｎを、電極膜６にはＣｕを各々用いた。ヘッド試作の最終工程で真空中磁界中熱処理に供して磁化固着膜８とそれに交換結合される磁化固定膜４２の磁化の向きを図１５の紙面表側から裏側へ向かう向き（すなわち媒体面に垂直な方向）に設定した。

【００９９】実際に用いたヘッドは上部に絶縁膜と磁気シールドと記録下磁極を兼ねたＣｏＺｒＮｂ膜、記録ギャップを介してＮｉＦｅ上部磁極を形成したものであり、記録・再生トラック幅は２μｍとした。本実施例の磁気ディスクを回転させて磁気ヘッドを浮上量０．０４μｍで浮上させ、記録再生試験を実施した。その結果、本実施例の磁気ディスクでは未記録状態においても記録磁性部材１２からの磁気信号と磁石部材１１からの磁気信号とは異なるので、とくにサーボライトしない場合であっても安定してトラッキング動作を実現することができた。これによって本発明の効果の一つが実証された。

【０１００】次に、図１６に示すように、上記の磁気抵抗再生型磁気ヘッドを用いて本実施形態の磁気ディスク１Ｄに情報の記録再生を行った。図１６は動作中の未記録状態の記録トラック上を走行するヘッドの磁化回転膜４１と記録媒体の様子を示す断面模式図である。

【０１０１】記録磁極への記録信号の印加と再生ヘッド電極６への横通電（図１５のなかで磁化回転膜４１中に図示した矢印に対して反対の向きに通電）とによって記録再生動作を行った。トラックＴ２上の磁化回転膜４１の磁化の向きは磁石部材Ｍ２及びＭ３からの漏洩磁界の向きに揃い、これは前述のように対称波形再生可能な磁化方向である。

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【０１０２】次に、記録動作を行うと磁化反転部からの漏洩磁界（媒体面に垂直で上向きもしくは下向き）に従って磁化回転膜４１の磁化が回転し、抵抗が変化して対称波形の再生信号が得られた。センス電流を増加させるとほぼ線形に再生信号強度は増加し、センス電流磁界と磁化固着膜８の磁化の向きが一致しているために磁化固着膜８の磁化方向の変化は見られなかった。

【０１０３】トラックＴ２に隣接するトラックＴ３で動作させた場合には、磁化回転膜４１の磁化の向きはトラックＴ２のときとは逆向きになるが、再生動作上はトラックＴ２とＴ３とは等価なのでまったく問題無く記録再生動作させることができた。

【０１０４】次に、再生ヘッドを記録済みのトラックから未記録のトラックへ少しずつディスク半径方向に送ってオフトラック特性を調べた結果、トラックピッチの２μｍの送りで全く信号は無くなり、本実施形態のディスク１Ｄがサイドフリンジを低下させる上でも効果的であることが明らかとなった。また、ＣＳＳ試験を繰り返し５千回行ったが、とくに媒体面の摩耗は認められなかった。ただし、媒体面にルブリカントを塗布してＣＳＳ試験した。これから明らかなように、磁石部材１１が記録磁性部材１２よりも硬質であれば、磁石部材１１がガイドレール的に作用してＣＳＳ耐性を向上させる効果を有することが判明した。

【０１０５】さらに、ＣＳＳ耐性を向上する上では磁石部材１１としてＴｂＣｏの代わりにフェライト系の磁石部材を用いることが効果的であり、そのような場合は保護膜無しでも５万パス程度の実用的なＣＳＳ耐性が期待でき、狭スペーシング化上も効果的である。なお、上記実施例に用いたＴｂＣｏ磁石層の場合は、媒体面上に１０ｎｍ程度のSiO_2保護膜を設けるのが実用上は好ましい。

【０１０６】（比較例）以上、本発明の効果を明確にした実験の結果を記述したが、比較例として従来の方法を用いて磁石部材を持たない磁気ディスクを作成し、これを上記実施形態のディスク１Ｄと同様に評価した。比較例ディスクの構成は、ガラス基板上に２０ｎｍのＣｏＰｔ記録層と１０ｎｍのSiO_2保護層をスパッタ形成し、その上にディスク１Ｄに用いたのと同様のルブリカントを塗布したものである。ディスク動作試験の条件は、ヘッド浮上量を０．０３μｍとしてヘッド／メディア間のスペーシングを変えたことを除き、ディスク１Ｄの条件と同じにした。

【０１０７】比較例ディスクからヘッドの磁化回転膜４１へ漏洩する磁界は未記録状態ではランダムなので、磁化回転膜４１の磁化方向は平均的に見て磁化固着膜８と磁化固定膜４２の漏洩磁界の向き、すなわち図１５で紙面に垂直な（裏から表）に向く。これに起因して記録磁区列を再生する際に、比較例ディスク媒体からの磁界が図１５中にて紙面の表から裏に向かう場合は磁化回転膜

４１の磁化が回転して再生信号が得られたが、裏から表に向かう場合は磁化回転膜４１の磁化は回転せず信号が得られなかった。すなわち、比較例ディスクでは再生信号出力は得られたものの磁化転移の半分に相当する出力しか得られなかった。

【０１０８】また、比較例ディスクにおいてはサーボライト無しでは未記録状態のトラックからは何等トラッキング情報が得られないので、次第にトラックずれを生じるとともに、サイドフリンジが大きくなって隣接トラックからの余分なノイズ信号の混入が大きくなるという不都合を生じた。

【０１０９】上記の実施例と比較例では、基板としてガラス、記録磁性層としてＣｏＰｔ膜、磁石層としてＴｂＣｏ膜、保護膜としてSiO_2を使用した例を述べたが、本発明はとくにこれらの材料のみに限定されず、基板にＡｌ等の金属を、記録磁性部材１２にＣｏＣｒＴａ、ＣｏＮｉＰｔ、ＣｏＣｒ、Ｂａフェライト等を、磁石部材１１にフェライト、ＳｍＣｏ、ＮｄＦｅ、ＭｎＢｉ等を、また保護膜としてＣ等の様々な材料を用いることができる。さらに、記録磁性部材１１の下地にＣｒ等の配向制御層、ＮｉＦｅ等の高透磁率層等が配置されていてもよい。

【０１１０】また、磁石部材の横断面形状も多用な変形例があげられ、矩形状以外にＶ字状、半円状でもよい。

【０１１１】また、上記実施形態の磁気ディスク１Ｄでは磁石部材１１を設ける領域の深さを記録磁性層１２の膜厚と同じにしたが、磁石部材１１の深さ（厚さ）は必ずしも記録磁性層１２の膜厚と同じであることを要しない。例えば図１７に示すディスク１Ｅでは、磁石部材１１ａの深さを記録磁性部材１２ａの膜厚より小さくしている。また、図１８に示すように、中間層（下地層）５を基板１ａと記録層２との間に有するディスク１Ｆでは、磁石部材１１ｂの深さを中間層３の膜厚と記録磁性部材１２ｂの膜厚とを合計したものとしてもよい。さらに、図１９に示すディスク１Ｇでは、磁石部材１１ｃの深さを記録磁性部材１２ｃの膜厚より大きくしている。

【０１１２】また、スピンバルブ構造以外の磁気抵抗効果形再生素子、例えば異方性磁気抵抗膜や、人工格子的な多層構造膜や、グラニュラー膜等に対しても同様の効果を得ることができる。すなわち、再生信号の対称性を得る上で何等かの動作点バイアスを必要とする磁気抵抗効果素子全般に対して同様の効果を奏する。

【０１１３】本実施形態の磁気ディスクを用いれば、磁気抵抗効果型再生ヘッドを有する磁気記録再生装置において、大きなセンス電流を通電できるので高い再生信号強度を得ることができ、良好な再生信号波形の対称性が得られるのでエラーレートの少ない再生動作が安定してでき、再生ヘッド構造が簡略化されるので安価にヘッドを製造できる。さらに付随的効果として、サイドフリンジの少ない記録が可能となり、かつ安定したトラッキング動作が可能となって狭トラック化が容易になり、かつ狭スペーシング動作をも可能たらしめる。

【０１１４】

【発明の効果】本発明によれば、硬質ガードバンド部材により記録磁性部材を互いに分離することで、サイドフリンジが大幅に低減化され、狭トラック化が容易となる。また、保護膜が無くても高耐久性を達成でき、狭スペーシング化が容易となり、かつ狭ビットピッチ化が容易となり、総合的に磁気記録の高密度化に貢献する所多大である。さらに、高価格化を招くことなく、硬質ガードバンド部材の形成が可能な磁気ディスク及びその製造方法が提供される。

【０１１５】また、本発明によれば、記録層下部に配置する膜に対する自由度が高く、面内媒体の場合は配向制御膜を配置する等して記録磁性厚を高密度記録対応の薄さに設定するのが簡単になり、垂直媒体では記録層下部に高透磁率層を配置する等して記録再生磁界を強めることが容易になる。また、硬質のガードバンド部材を採用することによりＣＳＳ耐性を大幅に向上することができるので、将来的には接触記録方式に対しても十分に応用できる。さらに、絶縁性のガードバンド部材を採用すれば磁気抵抗効果型ヘッドをディスク面に接触させることも可能であり、総合的に磁気記録の高密度化に大いに寄与する。

【０１１６】本発明の磁気ディスクによれば、媒体磁界によって磁気抵抗効果形ヘッドに適当な動作点バイアスを印加するので、簡単な再生素子構造を用いても対称波型の安定した再生動作が可能となり、再生素子の製造が簡便になる。

【０１１７】とくにサーボライトしない場合であっても安定して高精度のトラッキング動作をすることが可能となり、サイドフリンジの少ない記録が実現でき、かつ狭スペーシング動作がしやすくなるので、総合的に磁気記録の高密度化と高性能化に寄与するところが大である。

【図面の簡単な説明】

【図１】図１は、本発明の第１実施形態に係る磁気ディスクの一部を切り欠いて記録トラック部分を拡大して示す拡大斜視図。

【図２】図２は、磁気ディスクの製造方法を説明するために製造プロセスの一工程にあるディスクを示す縦断面図。

【図３】図３は、磁気ディスクの製造方法を説明するために製造プロセスの一工程にあるディスクを示す縦断面図。

【図４】図４は、磁気ディスクの製造方法を説明するために製造プロセスの一工程にあるディスクを示す縦断面図。

【図５】図５は、磁気ディスクの製造方法を説明するために製造プロセスの一工程にあるディスクを示す縦断面図。

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【図６】図６は、磁気ディスクを示す縦断面図。

【図７】図７は、他の実施形態の磁気ディスクを示す縦断面図。

【図８】図８は、他の実施形態の磁気ディスクを示す縦断面図。

【図９】図９は、他の実施形態の磁気ディスクを示す縦断面図。

【図１０】図１０は、磁気記録装置の全体概要斜視図。

【図１１】図１１は、磁気記録装置の制御系を示す構成ブロック図。

【図１２】図１２は、磁気ヘッドユニット及び磁気ディスクを模式的に示す部分拡大概要図。

【図１３】図１３は、ＧＭＲ型記録ヘッドの主要部を模式的に示す斜視図。

【図１４】図１４は、本発明の第２実施形態に係る磁気ディスクの一部を切り欠いて記録トラック部分を拡大して示す拡大斜視図。

【図１５】図１５は、本発明の効果を実証するための動

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作試験に用いた磁気抵抗効果型再生素子を示す縦断面図。

【図１６】図１６は、第２実施形態に係る磁気ディスクと動作中のヘッドとの磁化の向きの関係を示す模式図。

【図１７】図１７は、本発明の他の実施形態に係る磁気ディスクの記録トラック部分を示す縦断面図。

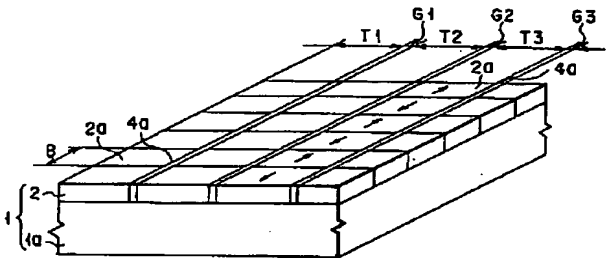
【図１８】図１８は、本発明の他の実施形態に係る磁気ディスクの記録トラック部分を示す縦断面図。

【図１９】図１９は、本発明の他の実施形態に係る磁気ディスクの記録トラック部分を示す縦断面図である。

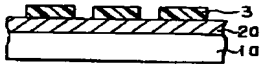
【符号の説明】

１ａ…基板、２…記録層、２ａ…記録磁性部材、３…レジスト層、４ａ…ガードバンド部材、５…下地層、６…再生ヘッド電極（Ｃｕ電極膜）、７…導電性非磁性膜（Ｃｕ膜）、８…磁化固着膜、１１，Ｍ２，Ｍ３，Ｍ４，Ｍ５…磁石部材（ＴｂＣｏ膜）、１２…記録磁性部材（ＣｏＰｔ膜）、４１…磁化回転膜、４２…磁化固定膜。

【図１】



【図２】



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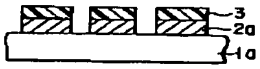

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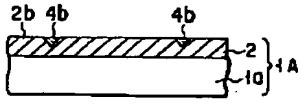

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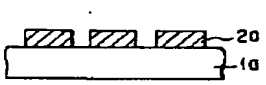
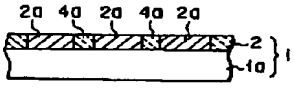


【図５】

【図６】



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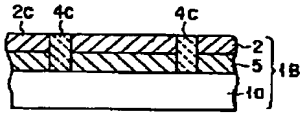

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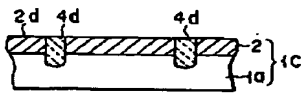

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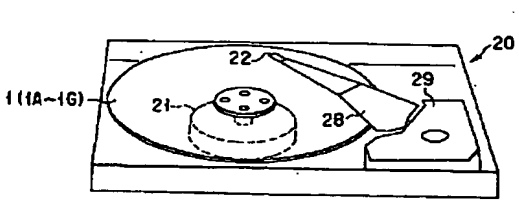

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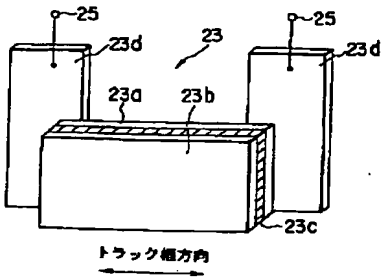
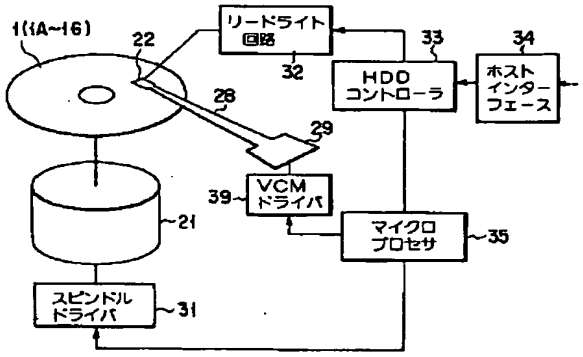


【図１１】



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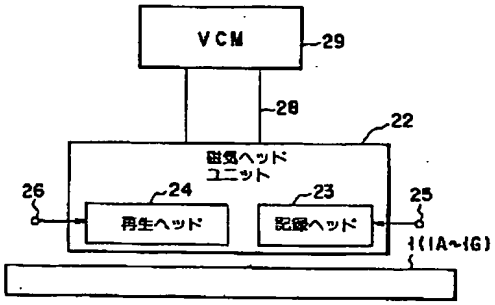

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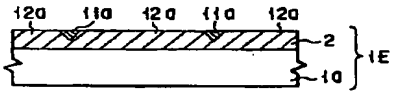

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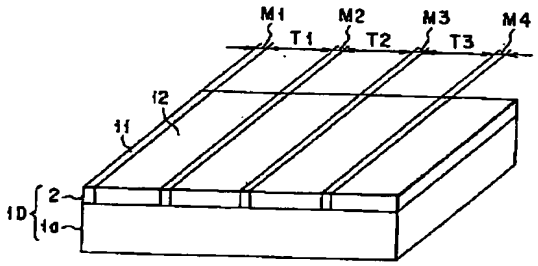

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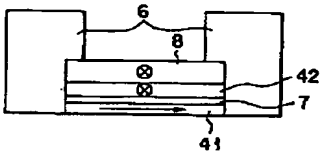

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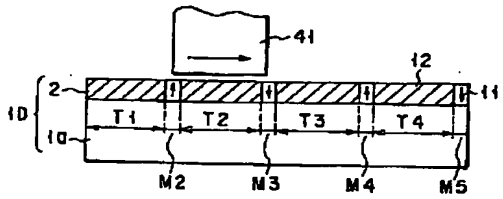

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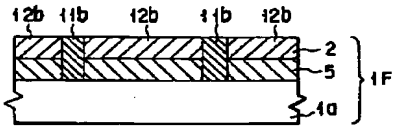
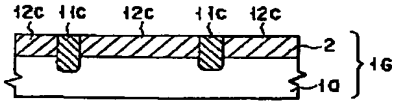


【図１９】



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TATEYAMA KOICHI

(30)Priority

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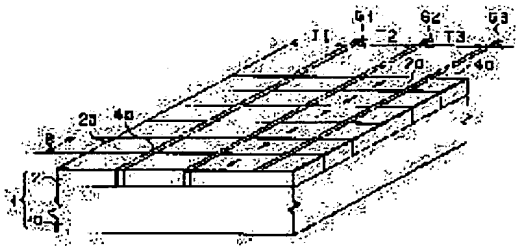
07192015 27.07.1995 JP

(54) MAGNETIC DISK, PRODUCTION OF MAGNETIC DISK AND MAGNETIC RECORDER

(57)Abstract:

PROBLEM TO BE SOLVED: To increase the density of magnetic recording by separating recording magnetic members from each other by hard guard band members.

SOLUTION: A substrate 1a is provided thereon with a recording layer 2. This recording layer 2 includes band-shaped magnetic members 2a long in the direction of the recording tracks and the guard band members 4a consisting of different materials embedded between these members 2a. The magnetic members 2a and the guard band members 4a are periodically and alternately arranged with the track pitch as one period in the radial direction of the disk in the recording layer 2. The track pitch is given by (T+G) and the effective recording magnetic domain area corresponding to the inverse number of the surface density is given by (T×G)×B when the width of the band-shaped recording magnetic members 2a, i.e., recording track width, is defined as T and the width of the band-shaped guard band members 4a, i.e., guard band width, as G and the length of the recording magnetic domains as B. The surface recording density attains about 1.5Gbpsi and the storage capacity with the drive of the four surfaces of two sheets of the disk attains 1.5GB when a disk substrate of a 2.5-inch size is used for the disk substrate 1 and the red track width T is set at 1.8±0.1μm and the guard width G at 0.2±0.1μm.



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[Date of request for examination] 16.01.2001

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] A substrate and the recording track section built with the magnetic member which is prepared on this substrate and carries out record playback of the information magnetically, The guard band member which was prepared so that it might continue in the direction of a truck substantially between said recording track sections which adjoin mutually, and was built with the nonmagnetic ingredient more firmly than said magnetic member, The magnetic disk characterized by preparing the magnetic member of different thickness from the thickness of the magnetic member which it provides, and the above-mentioned magnetic member does not exist in the lower part field of the above-mentioned guard band member, or makes the above-mentioned recording track section.
[Claim 2] The magnetic disk according to claim 1 characterized by the electric resistance of the above-mentioned guard band member being larger than the electric resistance of the magnetic member which makes the above-mentioned recording track section.
[Claim 3] Claim 1 characterized by the disk front face formed by the above-mentioned magnetic member and the above-mentioned guard band member being substantially flat, or a magnetic disk given in either of 2.
[Claim 4] The thickness of the above-mentioned guard band member is a magnetic disk according to claim 1 characterized by the thickness of the magnetic member which makes the above-mentioned recording track section, and the substantially same thing.
[Claim 5] The thickness of the above-mentioned guard band member is a magnetic disk according to claim 1 characterized by being smaller than the thickness of the magnetic member which makes the above-mentioned recording track section.
[Claim 6] The thickness of the above-mentioned guard band member is a magnetic disk according to claim 1 characterized by being larger than the thickness of the magnetic member which makes the above-mentioned recording track section, and laying a part of above-mentioned guard band member underground into a substrate.

[Claim 7] Furthermore, it is the magnetic disk according to claim 1 which has the substrate layer which consists of a NiP deposit, Cr orientation control layer, or the NiFe soft magnetism layers between the above-mentioned magnetic member and a substrate, and is characterized by the thickness of the above-mentioned guard band member being substantially [as the thickness which totaled the thickness of this substrate layer, and the thickness of the above-mentioned magnetic member] the same.
[Claim 8] the magnetic member which be prepare so that it may continue in the direction of a truck substantially between a substrate , the recording track section built with the magnetic member which be prepare on this substrate and carry out record playback of the information magnetically , and said recording track section which adjoin mutually , and make the above-mentioned recording track section be the magnetic disk characterize by to have the magnet member which be build with a magnetically different ingredient and supply a direct current field outside .
[Claim 9] The magnetic disk according to claim 8 characterized by the disk front face formed by the above-mentioned magnetic member and the above-mentioned magnet member being substantially flat.
[Claim 10] The thickness of the above-mentioned magnet member is a magnetic disk according to claim 8 characterized by the thickness of the magnetic member which makes the above-mentioned recording track section, and the substantially same thing.
[Claim 11] The thickness of the above-mentioned magnet member is a magnetic disk according to claim 8 characterized by being smaller than the thickness of the magnetic member which makes the above-mentioned

recording track section.
[Claim 12] The thickness of the above-mentioned magnet member is a magnetic disk according to claim 8 characterized by being larger than the thickness of the magnetic member which makes the above-mentioned recording track section, and laying a part of above-mentioned magnet member underground into a substrate.
[Claim 13] Furthermore, it is the magnetic disk according to claim 8 which has the substrate layer which consists of a NiP deposit, Cr orientation control layer, or the NiFe soft magnetism layers between the above-mentioned magnetic member and a substrate, and is characterized by the thickness of the above-mentioned magnet member being substantially [as the thickness which totaled the thickness of this substrate layer, and the thickness of the above-mentioned magnetic member] the same.
[Claim 14] The above-mentioned magnet member is a magnetic disk according to claim 8 characterized by being made of the ingredient which has the coercive force of magnitude from which the magnetization direction does not change with the magnetic heads for record.
[Claim 15] (a) The process which forms the magnetic layer which consists of a magnetic material on the substrate which has a flat front face substantially, (b) The process which carries out pattern formation of the guard band tooth space which specifies the recording track section which adjoins mutually so that a part of this magnetic layer may be removed and it may continue in the direction of a truck substantially, (c) The process which fills this guard band tooth space with the guard band member which consists of a nonmagnetic ingredient more firmly than the magnetic material which makes said magnetic layer, (d) The manufacture approach of the magnetic disk characterized by having the process processed so that the front face of this guard band member and said magnetic layer may become flat respectively substantially.
[Claim 16] (A) The process which forms the magnetic layer which consists of a magnetic material on the substrate which has a flat front face substantially, (B) The process which carries out pattern formation of the tooth space which specifies the recording track section which adjoins mutually so that a part of this magnetic layer may be removed and it may continue in the direction of a truck substantially, (C) The process filled with the magnet member which is built with a magnetically different ingredient from said magnetic material in this tooth space, and supplies a direct-current field outside, (D) The manufacture approach of the magnetic disk characterized by having the process processed so that the front face of this magnet member and said magnetic layer may become flat respectively substantially.
[Claim 17] A substrate and the recording track section built with the magnetic member which is prepared on this substrate and carries out record playback of the information magnetically, The guard band member which was prepared so that it might continue in the direction of a truck substantially between said recording track sections which adjoin mutually, and was built with the nonmagnetic ingredient more firmly than said magnetic member, [whether the above-mentioned magnetic member exists in the lower part field of the above-mentioned guard band member by providing, and] Or the magnetic disk with which the magnetic member of different thickness from the thickness of the magnetic member which makes the above-mentioned recording track section is prepared is received. The magnetic head which reads information magnetically and writes it in, and the control section which writes in, carries out data processing of the information, and sends the information which is sent from an external device, and by which data processing was carried out to said magnetic head through a read/write circuit, A preparation and the above-mentioned magnetic head possess the magnetic resistance element of a spin bulb mold. This spin bulb type of magnetic resistance element The 1st magnetic layer by which it connected with the above-mentioned read/write circuit, and magnetization was perpendicularly fixed to the field of the above-mentioned magnetic disk, The magnetic recording medium characterized by having the nonmagnetic conductive layer inserted between the 2nd magnetic layer from which magnetization changes with impression fields, and this 2nd magnetic layer and the 1st magnetic layer of the above.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of the magnetic disk mainly used for a calculating-machine circumference store, and a magnetic disk, and a magnetic recording medium.
[0002]
[Description of the Prior Art] The magnetic disk has the features, such as high surface recording density, a high data transfer rate, rapid access, high-reliability, and a low price, and is making the mainstream of computer circumference storage. The surface recording density of a magnetic disk showed several 10 times as many elongation as this in the past ten years, and improvement in the surface recording density continues to be promising.
[0003] Magnetic recording makes it a principle to reproduce the signal field which forms a record magnetic-domain train into a magnetic-recording layer, records, and is revealed to the recording layer exterior from this record magnetic-domain train by the signal field generated from the magnetic head by the magnetic head. When improving surface recording density, it is the point what-izing of the record magnetic domain formed into a magnetic-recording layer can be carried out [detailed] or how the minute field revealed from a detailed record magnetic domain is reproducible to high sensitivity.
[0004] When making a record magnetic domain detailed, on making it detailed and a twist concrete target, the magnetic-head point which touches the 1st recently at a magnetic-recording layer It is in narrowing a record (playback) magnetic gap and narrowing the record (playback) magnetic pole width of recording track, and the gap (spacing) of a magnetic-head point and a magnetic-recording layer is narrowed the 2nd, Positioning [as much as possible / with high degree of accuracy]-in predetermined record playback location of magnetic-recording layer-magnetic-head point ** is important for reducing a blot (fringing) of the record magnetic-domain edge by the field spatially emitted from a magnetic-head point to the 3rd as much as possible, and the 4th.
[0005] moreover -- when carrying out high sensitivity playback of the minute field from a detailed record magnetic domain -- playback -- the theoretic breakthrough is needed. Since the playback principle using a different magneto-resistive effect from the conventional induction playback principle is proposed and proved in recent years and researches and developments of a giant magneto-resistance ingredient are furthered further, it is regarded as what makes the mainstream of future minute field playback.
[0006] The technical point to the densification of the above-mentioned record playback consistency is a matter which is common also with the record playback gestalt (induction playback mold) of the head floatation form using the longitudinal medium adopted by the present magnetic recording, or the record playback gestalt (magnetic-reluctance playback mold) of the head contact form using a vertical medium.
[0007] It can consider as the policy which reduction-izes fringing, and reduction of the fringe magnetic field from the head by the formation of a ** spacing and reduction-ization of the magnetization transition width of face of a recording layer can be raised from the former. However, in the conventional magnetic disk, since it is impossible, abolishing fringing theoretically needs to consider as the width of recording track it is possible to have expected a certain fringe value, and it has become the inhibition factor of narrow-track-izing.
[0008] Moreover, the actual condition is recording a magnetic servo signal and a magnetic address signal into a recording layer using a servo writer, and carrying out by using this servo information during real actuation about positioning of a head, after installing a magnetic-recording disk and the magnetic head in a drive.

However, since tracking precision is restricted to the mechanical precision of a head as long as a magnetic-recording layer is the flat side which continues simply, this is also the inhibition factor of narrow-track-izing.
[0009] One approach of the formation of high-degree-of-accuracy tracking is a discrete truck indicated by JP,2-201730,A. This prepares physical irregularity in the magnetic-disk substrate beforehand, forms a magnetic-recording layer on this, and performs a truck servo using the difference between the signal from a crevice, and the signal from heights. By such PERM (Pre Embossed Rigid Magnetic) disk, tracking precision is determined in the precision of physical irregularity prepared in a substrate, and irregularity can realize high-degree-of-accuracy-ization whose amount of fluctuation is 0.01-micrometer order extent, if it prepares according to an optical disk substrate process.
[0010] Since the member which makes a guard band in the above-mentioned PERM disk is an elastic resist, it is tended selectively however, to wear only a resist out. It cannot be synthetically said to be a high-degree-of-accuracy-ized technique from it being necessary to cover a disk front face with a hard protective coat, and being hard to form it into a ** spacing, in order to prevent this wear.
[0011] The thick film of the organic system represented by the resist is prepared on a substrate, it carries out pressing an irregularity-like stamper against it etc., physical irregularity is prepared in an organic film top face, and the magnetic-recording medium by which a magnetic-substance thin film is embedded all over a crevice, and the organic film and the magnetic-substance film make a flat side substantially is indicated by JP,2-189715,A. By this magnetic-recording medium, since the organic film exists, for forming an interface invalid layer in the magnetic-substance film lower part thickly, and obtaining the magnetic-substance film of a predetermined property, the lower part of the magnetic-substance film does not obtain a thick kink colander, and cannot say thickness of the magnetic-substance film as a densification technique too from superresolution record being difficult. Furthermore, since the high permeability film cannot be prepared in the record magnetic-substance film lower part in this conventional technique, application to the vertical magnetic recording expected as a future high density record technique is difficult.
[0012] Moreover, to the field between recording tracks of a magnetic-recording layer, carry out carrying out laser radiation etc., a record function is made to lose, and the ion implantation or the technique to make is proposed as the guard band by the Japanese-Patent-Application-No. No. 205257 [five to] official report. However, with this conventional technique, since the affected zone of a recording layer is used for a guard band, there is a trouble that it is difficult to form a homogeneous guard band, and the boundary of a recording track and a guard band becomes indefinite.
[0013] By the way, a "magneto-resistive effect" is the effectiveness that electric resistance changes with external magnetic fields, and there are a phenomenon (AMR) in which the electric resistance value of the magnetic-substance thin film for (a) playback changes depending on the relative include angle of the sense of a current and the sense of magnetization of the playback magnetic substance, a phenomenon (GMR) in which resistance changes by whenever [angular relation / of the magnetization between the magnetic layers to which the laminating was carried out through the (b) non-magnetic layer], etc. This has the features that playback sensibility is dramatically high as compared with the conventional induction playback, and regenerative-signal reinforcement is not dependent on a head travel speed.
[0014] Four kinds of the granular structure which distributed the magnetic particle, for example, NiFe/Ag, and the magnetic artificial grids structure which carried out the laminating of many magnetic-substance thin films and many conductive nonmagnetic thin films by turns, for example, (Co/Cu), n film **, are raised into the spin bulb structure which uses an anisotropy magneto-resistive effect, for example, put the conductive nonmagnetic membrane with NiFe monolayer and two magnetic-substance thin films as structure of the magnetic substance used for a magnetoresistive head, for example, CoFe/Cu/CoFe 3 layer membrane, and a conductive nonmagnetic member.
[0015] Among these, since the thing of monolayer membrane structure is comparatively simple for creation of a component, it is in practical use level, but since resistance rate of change is only about 2% at most, when detailed-ization of a record magnetic domain, i.e., micrifying of a playback field, will progress further from now on, it considers as imperfection in playback sensibility.
[0016] Moreover, although granular structure and magnetic artificial grids structure present several 10% or more of resistance rate of change and whenever [expected] will be very high in the future, when obtaining a big resistance change, in order to require the big field of number kOe- number 10kOe, playback of a minute

medium field is made difficult in the actual condition.
[0017] Then, the spin bulb structure which presents about 10% of practically sufficient resistance rate of change by comparatively small field change of less than hundreds of Oes attracts attention, and the utilization is most expected as a next playback component of monolayer membrane structure. With the relative sense of magnetization of two magnetic-substance thin films, the playback principle of spin bulb structure is in the place where electrical resistivity changes, and fixes the sense of magnetization of one magnetic-substance thin film actually, and it makes the sense of magnetization of another magnetic-substance thin film follow in footsteps of sense of a medium field, changes the relative sense relation of magnetization of two magnetic-substance thin films, and it is used for it. For immobilization of magnetization of the magnetic-substance thin film of one side, switched connection is carried out to this film by using the high magnetic-substance film of coercive force as the magnetization fixing film, and it considers as the magnetization fixed film. Since the magnetic-substance thin film of one side follows in footsteps of a medium field and the magnetization rotates it, this is already written as the "magnetization revolution film" below. If it is important for the sense of magnetization of this magnetization revolution film in the condition that there is no medium field to consider as the sense and the rectangular condition of magnetization of the magnetization fixed film when securing the symmetric property of a regenerative signal, and relation with the sense of a medium field is also included The magnetization direction of the magnetization fixed film is set up in the direction vertical to a medium field and the same direction, i.e., a medium side, and, as for the magnetization direction of one magnetization revolution film, it is desirable that it is suitable crosswise [of a medium / truck] in the condition that there is no medium field.
[0018] Some methods are adopted as setting out of the magnetization direction of the above-mentioned magnetization fixed film and the magnetization revolution film. Utilization of the magnetization fixing film is common to setting out of the magnetization direction of the magnetization fixed film, and the following two approaches are proposed by setting out of the magnetization direction of one magnetization revolution film. There is a method of using for the 1st the field generated according to a sense current, and there is switched connection or the approach of carrying out magnetostatic association about the hard film for impressing a moderate bias field to the 2nd also at the magnetization revolution film.
[0019]
[Problem(s) to be Solved by the Invention] However, by the approach using the former sense current, since the bias field to that high power-ization by high-current-izing cannot be attained since a sense current value is prescribed by the bias field to the magnetization revolution film, and the magnetization revolution film acts on the sense which reverses the magnetization direction to the magnetization fixed film, it has troubles -- it is hard to secure the dependability on actuation.
[0020] On the other hand, by the approach using the latter hard film bias, the membrane structure of a head is complicated, a manufacture process routing counter increases, and there are troubles, like it is difficult to offer a head cheaply.
[0021] As mentioned above, although the example of spin bulb structure was taken and the importance of the bias at the time of using a magneto-resistive effect component and a concrete means were explained, it is required to make the revolution of magnetization into the symmetry to the sense of a medium field practically, when using the magneto-resistive effect film of which other structures, when preventing waveform distortion, and to the magneto-resistive effect film, with a certain means, bias of the field is carried out and it uses.
[0022] The object of this invention can reduce the side fringe of a record magnetic domain, and is to offer the magnetic disk which can raise the positioning accuracy of the magnetic head also at the time of a ** spacing, and its manufacture approach.
[0023] Moreover, the object of this invention can be set as the thickness which can high-resolution record the thickness of the record magnetic-substance film, can be applied also to a future vertical magnetic recording or contact record, and is to offer the magnetic disk suitable for especially a magneto-resistive effect mold recording head in which high density record is possible, and its manufacture approach.
[0024] Furthermore, the object of this invention can pass a big sense current to the magneto-resistive effect mold record reproducing head, and the operational reliability of a head can be secured and it is to offer the magnetic disk which can manufacture a head cheaply, and its manufacture approach.
[0025] Furthermore, the object of this invention has few side fringes, and they are to offer the magnetic disk which enables actuation of the ** spacing record by which the tracking servo property was stabilized, or contact

record, and its manufacture approach.
[0026] Furthermore, the object of this invention is to offer the magnetic recording medium in which high density record is possible with large capacity.
[0027] The recording track section built with the magnetic member which the magnetic disk concerning this invention is formed on a substrate and this substrate, and carries out record playback of the information magnetically, The guard band member which was prepared so that it might continue in the direction of a truck substantially between said recording track sections which adjoin mutually, and was built with the nonmagnetic ingredient more firmly than said magnetic member, It is characterized by preparing the magnetic member of different thickness from the thickness of the magnetic member which it provides, and the above-mentioned magnetic member does not exist in the lower part field of the above-mentioned guard band member, or makes the above-mentioned recording track section.
[0028] The process which forms the magnetic layer which consists of a magnetic material on the substrate with which the manufacture approach of the magnetic disk concerning this invention has a flat front face in (a) real target, (b) The process which carries out pattern formation of the guard band tooth space which specifies the recording track section which adjoins mutually so that a part of this magnetic layer may be removed and it may continue in the direction of a truck substantially, (c) The process which fills this guard band tooth space with the guard band member which consists of a nonmagnetic ingredient more firmly than the magnetic material which makes said magnetic layer, (d) It is characterized by having the process processed so that the front face of this guard band member and said magnetic layer may become flat respectively substantially.
[0029] the above-mentioned guard band member -- a disk front face -- even appearing -- it may be the same as the thickness of a magnetic member, and the thickness may be thicker than this and may be [that what is necessary is just to be] thinner than this.
[0030] Moreover, it is desirable that it is made of nonmagnetic hard material, and a guard band member is SiO2, aluminum 2O3, and TiO2. It is desirable that it is made of one of polymerization compounds among a nitride like an oxide [like], Si3 N4, AlN, and TiN, carbide like TiC, boride like BN or C system, CH system, and CF system. Since a guard band member is nonmagnetic, the problem of a side fringe is solved nearly thoroughly. Moreover, a guard band member becomes what excelled the magnetic member in contact start stop (CSS) resistance since it was hard, and was excellent in endurance also in the contact recording method of further the future.
[0031] In the magnetic disk of this invention, the magnetic member itself is making a physical configuration change of the shape of detailed irregularity. It is desirable to embed a guard band member to the heights front face of a magnetic member in the crevice of this magnetic member, and for a disk front face to make a flat side substantially. The concavo-convex configuration of a magnetic member is important, and when reducing side fringing and performing the tracking of high degree of accuracy, it is desirable to be substantially prepared in the direction of a recording track continuously. The high-degree-of-accuracy tracking of resemblance in an optical disk of it becomes possible at the same time the problem of side fringing is intrinsically solvable, because a guard band member takes such a gestalt.
[0032] Here, although there is nothing, the need that the semantics of "continuing substantially" covers a truck round and the guard band member is not necessarily continuing covers the magnetic servo information record part which will be prepared if there is a record magnetic-domain train formation part or need, succeeding the direction of a truck, is clear and should just be. the configuration in which a more desirable concavo-convex configuration continues in said direction of a truck carried out substantially -- in addition, the address signal which will be prepared if there is need in the direction of a truck in addition to the configuration which carries out abbreviation continuation is the gestalt by which information record is carried out as configuration change of a record magnetic layer. If such a gestalt is taken, the need for the servo lighting currently carried out from the former will completely be lost.
[0033] moreover, a high density record top -- as the effectiveness of important this invention -- record -- the improvement in resolution, i.e., the improvement in track recording density, can be raised. By separating a record magnetism member for every recording track section by the nonmagnetic guard band member, the magnetic shape anisotropy of a magnetic member is given in the direction of a recording track, and this requires fluctuation of the regenerative signal in the magnetization transition section for becoming small.
[0034] The guard band member and the magnetic member side which are embedded in the concavo-convex

section of a record magnetism member are substantially become unnecessary to prepare a wear-resistant protective layer on a flat side, then a recording layer. In such a case, it is the most desirable gestalt when reducing spacing loss. When making the recording surface of a disk carry out contact transit of the magnetic head, a guard band member has the role of the guide rail to which it shows the magnetic head. In addition, by the contact recording method, if the record magnetism member is exposed, when sufficient dependability will not be acquired, a protective layer may be prepared. As for a protective layer, it is desirable that it is the hard nonmagnetic member which consists of the same construction material as a guard band member.

[0035] Furthermore, the larger one of the electric resistance of a guard band member than the electric resistance of a magnetic member is desirable. When taking into consideration record playback of a magneto-resistive effect method, as for a guard band member, it is desirable to have insulation electrically compared with a record magnetism member, and it is desirable to have a value [at least] higher about single figure than a record magnetism member as resistivity. If it does in this way, when contact playback is carried out using the magnetoresistive head of a horizontal energization method, a current can also solve the problem of revealing to a medium and reducing a playback output.

[0036] Since Co system ingredient used for the usual magnetic disk, for example, CoNiPt, CoPt, CoPtCr, CoTaCr, CoNiCr, CoCr expected as a future vertical-magnetic-recording ingredient, CoPtO, and itself are hard as a magnetic member, the ingredient system which distributed Ba ferrite system, Fe system, or Co system particle currently studied as a contact record ingredient in the hard matrix can be used.

[0037] In addition, although a substrate may be arranged directly at the substrate of a record magnetism member, it is good to form the high permeability film, for example, the NiFe film etc., as closed magnetic circuit formation film to vertical media, such as NiP and Cr, to the medium within a field as orientation control film preferably. Although especially the ingredient of a substrate is not limited, aluminum and glass are usually used. Furthermore, it is desirable to use the glass substrate which is excellent in chemical resistance.

[0038] it be prepare so that it may continue in the direction of a truck substantially between a substrate , the recording track section built with the magnetic member which be prepare on this substrate and carry out record playback of the information magnetically , and said recording track section which adjoin mutually , and the magnetic member which make the above-mentioned recording track section be build with a magnetically different ingredient , and the magnetic disk concerning this invention be characterize by to have the magnet member which supply a direct current field outside .

[0039] The process which forms the magnetic layer which consists of a magnetic material on the substrate with which the manufacture approach of the magnetic disk concerning this invention has a flat front face in (A) real target, (B) The process which carries out pattern formation of the tooth space which specifies the recording track section which adjoins mutually so that a part of this magnetic layer may be removed and it may continue in the direction of a truck substantially, (C) -- the process filled with the magnet member which is built with a magnetically different ingredient from said magnetic material in this tooth space, and supplies a direct-current field outside, and (D) -- it is characterized by having the process processed so that the front face of this magnet member and said magnetic layer may become flat respectively substantially.

[0040] "In succession", it means that the magnet member should just exist in record/playback part of an information signal at least substantially [the direction of a truck]. Therefore, there may be a magnet member in an address information field and a servo information field, or you may not be, and it is the thing of arbitration.

[0041] Moreover, address information and servo information may be established with a magnet member pattern, and in such a case, the magnet member of this part is continuing in the direction of a truck substantially, and it does not matter that there is nothing.

[0042] Although it is common to consider as a direction parallel to a recording track parallel to a medium side as for the direct-current field generated outside (the direction of a head) from a magnet member, when using the magnetic-reluctance playback component of a vertical energization method, it is good to make it generate at right angles to a medium side.

[0043] Furthermore, a magnetic disk may be equipped with a substrate layer, a protective layer, a lubricating layer, etc. if needed.

[0044] It is desirable to use Co-P, the Co-nickel-P plating film, the Co-nickel vacuum evaporationo film, Ba ferrite spatter film, Co-Pt, Co-Cr, Co-nickel-Cr, Co-Cr-Ta, and Co system spatter film of Co-nickel-Pt for a magnetic member.

[0045] As long as a magnet member is an ingredient which has big coercive force in extent from which the magnetization direction does not change with the record media of the magnetic head, it may be the thing of what kind of construction material. The magnitude of a generating field is important and this can be adjusted also by preparing the soft magnetism film in the size (width of face and thickness) of a magnet member, and the substrate of a magnet member in addition to the value (value depending on a material property and the manufacture approach) of magnetization of a magnet member. For example, as a magnet member, bulk magnet ingredients, such as a ferrite system, a SmCo system, and a NdFeB system, may be thin-film-ized, and may be used, and a high coercive force thin film material which is used for the Lords, such as a Pt/Co multilayer system, a MnBi system, a TbCo system, and a TbFeCo system, by the magneto-optic-recording medium may be used.
[0046] The recording track section built with the magnetic member which the magnetic recording medium concerning this invention is formed on a substrate and this substrate, and carries out record playback of the information magnetically, The guard band member which was prepared so that it might continue in the direction of a truck substantially between said recording track sections which adjoin mutually, and was built with the nonmagnetic ingredient more firmly than said magnetic member, [whether the above-mentioned magnetic member exists in the lower part field of the above-mentioned guard band member by providing, and] Or the magnetic disk with which the magnetic member of different thickness from the thickness of the magnetic member which makes the above-mentioned recording track section is prepared is received. The magnetic head which reads information magnetically and writes it in, and the control section which writes in, carries out data processing of the information, and sends the information which is sent from an external device, and by which data processing was carried out to said magnetic head through a read/write circuit, A preparation and the above-mentioned magnetic head possess the magnetic resistance element of a spin bulb mold. This spin bulb type of magnetic resistance element It connects with the above-mentioned read/write circuit, and is characterized by having the nonmagnetic conductive layer inserted between the 1st magnetic layer by which magnetization was perpendicularly fixed to the field of the above-mentioned magnetic disk, the 2nd magnetic layer from which magnetization changes with impression fields, and this 2nd magnetic layer and the 1st magnetic layer of the above.
[0047]
[Embodiment of the Invention] Hereafter, the gestalt of various operations of this invention is explained, referring to an attached drawing.
[0048] Drawing 1 is the amplification perspective view showing some magnetic disks concerning the example of this invention. All over drawing, sign 1a expresses a substrate and a sign 2 expresses a recording layer. The recording layer 2 contains guard band member 4a which consists of a different ingredient from record magnetism member 2a which makes band-like [long] in the direction of a recording track, and record magnetism member 2a embedded between record magnetism member 2a. Thus, in the recording layer 2, magnetic member 2a and guard band member 4a are periodically arranged by turns by the disk radial considering the track pitch as one period.
[0049] If it sets to T, band-like width of face, i.e., recording track width of face, of record magnetism member 2a, it sets to G, band-like width of face, i.e., guard band width of face, of guard band member 4a, and the die length of a record magnetic domain is set to B, a track pitch will be given by (T+G) and an effectual record magnetic-domain area equivalent to the inverse number of surface density will be given by x(T+G) B. In this example, 1.8**0.1 micrometers and guard band width of face G were set to 0.2**0.1 micrometers for the recording track width of face T, using the thing of 2.5 inch size as disk substrate 1a. When these set the aspect ratio (a track pitch / shortest bit pitch) of a record cel to 10 like the present magnetic-recording disk and it adopts a zone contact angular velocity (ZCAV) method as record on a disk, surface recording density is equivalent to the track pitch from which memory capacity is set to 1.5GB in a 1.5Gbpsi extent and two-sheet disk [4th page] drive.
[0050] Next, the manufacture approach of a magnetic disk is explained, referring to drawing 2 - drawing 6 . Glass disk substrate 1a [finishing / washing] was laid on the processing base of plural magnetron sputtering equipment, the spatter of the CoPt (20 atom %Pt) target was carried out for about 1 minute, and record MAG layer 2a of the magnetization within a field whose thickness is about 20nm was formed. Furthermore it continues and is SiO2. The spatter of the target is carried out for 1 minute, and it is SiO2 of about 10nm of

thickness. The film was formed and taken out.
[0051] Next, SiO2 of the disk after this film deposition Exposure processing of the resist 3 was carried out by track pitch 2micrometer and exposure width of face of 0.2 micrometers (the width of face G1 of guard band section 4a, G2, G3, --Gn), rotating a disk 1 with high degree of accuracy using the original recording cutting equipment for optical disks which makes Kr laser the light source, after carrying out about 50nm spin coat of the positive form resist 3 and prebaking it on the film. In addition, time amount which exposure of the whole disk surface takes was set as for about 10 minutes. The development was presented and the concentric circular resist pattern was formed on recording layer 2a. As shown to FIG2, recording track section 2a of a recording layer 2 is SiO2. The part which a resist coat is carried out through the film and is equivalent to guard band section 4a is SiO2. It was covered only with the film and the resist suited the condition that there was nothing.
[0052] Next, the disk 1 which has this resist pattern is inserted in in an RIE system, and it is CHF3. Gas is used and it is SiO2. For about 30 seconds carried out reactive ion etching of the film. After exposing recording layer 2of guard band section 4a a, the disk was inserted in in resist-ashing equipment and the resist pattern on recording track section 2a was removed.
[0053] Next, SiO2 The disk which has a film pattern was inserted in in the RIE system, the disk was heated at about 200 degrees C, and for about 1 minute carried out reactive ion etching of the CoPt film using the mixed-gas plasma which uses chlorine and boron trichloride as a principal component. By carrying out etching clearance to the substrate side of a substrate, as shown to FIG3, the band-like guard band tooth space was formed between adjacent CoPt recording layer 2a. Furthermore, as shown to FIG4, the ashing device removed the resist 3.
[0054] Next, as a disk with a guard band tooth space is inserted in in a sputtering system, a spatter is carried out for about 2 minutes until a guard band tooth space is buried thoroughly, and shown to FIG5, it is a disk front face SiO2 It covered by the film. This was taken out and it inserted in in ion polishing equipment, and the disk side was ground for about 30 seconds until the top face of record magnetism member 2a was exposed. SiO2 which was making the concavo-convex side on the recording layer to coincidence by this Flattening of the film 4 is carried out. Consequently, as shown to FIG6, the disk 1 with which band-like record magnetism member 2a and guard band member 4a appeared in the front face by turns was obtained.
[0055] When some obtained disks 1 were destroyed and the cross-section structure was observed with the electron microscope, as shown in drawing 1 , the thing in which record magnetism member 2a and guard band member 4a do not have a level difference and for which it has a smooth front face substantially was checked.
[0056] In addition, by production-facility enhancement, the increment of the total process time amount in this example is extent which can fully be compensated, and can suppress lifting of disk cost to small extent.
[0057] Moreover, although it explained per in the above-mentioned example when reactive ion etching was used for patterning of a magnetic film, the ion milling method can also be used. In that case, it is SiO2 on a magnetic film. It is not necessary to prepare, the coat of the direct resist is carried out, after carrying out laser exposure, patterning of the magnetic film is carried out by ion milling, and a resist is removed, and it is SiO2. What is necessary is just to embed and carry out an ion polish. However, process tolerance was excellent in the direction of reactive ion etching.
[0058] In the ingredient which accomplishes the mask or guard band at the time of carrying out patterning of the magnetic film, it is SiO2. Although ingredients other than record magnetism can be used freely suitably for except, a good insulating ingredient is preferably better than a record magnetism member hard. When it is not limited to an ingredient, for example, uses C for a mask, mask patterning especially of the manufacture process top can be carried out with oxygen gase gas.
[0059] The demonstration trial which clarifies effectiveness of this invention in the following procedures using the magnetic disk of this invention made as an experiment by the above-mentioned manufacture approach was carried out. Moreover, according to the conventional technique, the magnetic-recording disk was created in order to clarify the effectiveness of this invention in the demonstration trial described below, and it evaluated simultaneously. This conventional magnetic-recording disk is what took out the CoPt magnetic layer on the glass substrate in the above-mentioned example in the phase which carried out spatter formation (it is henceforth written as the comparison disk A), a 20nm CoPt recording layer, and 10nm SiO2. They are two kinds of what took out the layer (it functions as a protective layer in the conventional technique) in the phase which carried out the spatter (it is henceforth written as the comparison disk B).

[0060] The result hereafter examined about the disk (henceforth the example disk C) concerning the example of this invention and the comparison disks A and B is explained.
[0061] First, static magnetic properties were measured using vibrating sample ignition-magneto meter (henceforth VSM) per [which was respectively created on the same conditions] sample with the obtained disk sample. Since the disk sample of this invention possessed the nonmagnetic member other than a record magnetism member in the recording layer, based on the cross-section electron microscope observation result, the magnitude of magnetization was determined in quest of the volume of a net magnetic member.
[0062] It seemed that magnetization of the magnetic member of a recording layer had the easy shaft in a truck and parallel by the example disk C although it was as perpendicular as the truck parallel direction and the significant difference was not looked at by the VSM loop formation by the comparison disks A and B as a result of being two kinds of a direction vertical to a direction parallel to the recording track of the film surface Uchihira side shown in drawing 1 and measuring VSM measurement. Since the magnetic member had shape anisotropy in parallel in the recording track, this is considered, and it can be considered that a magnetic-recording top is a desirable thing.
[0063] As for the magnitude of saturation magnetization, the example disk C and the comparison disks A and B were not seen, as for about 650 emu(s)/cc and a significant difference.
[0064] Among the comparison disks A and B, although there was no significant difference and it was 2kOe extent, as for coercive force, the case where the case where values differed in the measurement direction in the example disk C, and a field is impressed to a truck parallel direction impressed a field to 2.5kOe(s), a truck, and a perpendicular direction showed 1.5kOe(s) and the value reflecting shape anisotropy. Although it was important for the densification top of magnetic recording that it is high coercive force, since the record magnetic domain was arranged in the direction of a recording track, also when shortening record wavelength, as for the structure of the magnetic-recording disk of this invention, the effective thing became clear from a viewpoint of static magnetic properties on densification.
[0065] Next, the 2.5 inch disk for an example and a comparison (the lubricant was applied) was installed in the magnetic-disk testing device, and comparative evaluation of tracking servo precision and record playback actuation were performed. The magnetic head used the thin film head of the horizontal energization magneto-resistive effect playback mold specially made as an experiment so that narrow track actuation of this invention might be possible. The flying height in rated revolution actuation was set to 0.04 micrometers by the example disk C and the comparison disk A, and it is referred to as 0.03 micrometers and made the width of recording track of the magnetic head set record playback to 2 micrometers, and for a head-media spacing to be set to 0.04 micrometers by every disk by the comparison disk B, when clarifying effectiveness of this invention. Moreover, the control system which carries out alignment of the magnetic head to the radius of the arbitration on a disk, and carries out tracking so that a suitable signal may be recorded and a regenerative signal may become max to a mechanical truck gap was used.
[0066] First, the result of a tracking performance test is described. The tracking property after the example disk C and the comparison disks A and B record a suitable signal was mostly in agreement. Next, a signal is recorded on the next truck, without recording on an adjoining truck. The place which sent the head to the truck which was not recorded and continued the revolution of a disk, Originate in the disk for a comparison which acquires a tracking signal only from a magnetic-recording signal running short of the mechanical rotational accuracy of a spindle motor, and a gap of a truck is generated gradually. Since the magnetic disks of this invention completely differed in a magnetic signal output with the guard band section also by truck in the condition of not recording, to having come to reproduce the record signal of an adjoining truck gradually, there was no generating of a tracking gap. Therefore, since there is no need of filling in a tracking servo signal beforehand, format effectiveness improves, user data volume increases, especially when driving by actual drive with the magnetic disk of this invention, and also an address signal can be filled in at the time of magnetic film patterning of disk creation time, it is clear that there is no need for a servo lighting.
[0067] Next, off-track playback actuation and over-writing actuation estimated the side fringe property at the time of recording a narrow track pitch as shown in drawing 1 . The used magnetic head is the same as that of what was used for the above mentioned tracking assessment. First, the off-track was applied little by little, applying offset to a tracking signal, after performing signal record on the truck of a suitable location, and the relation between the amount of off-tracks and regenerative-signal reinforcement was measured. Consequently,

since it observed with the magnetic-force microscope (henceforth MFM) on both sides of the head width of recording track by the comparison disks A and B and the every about 0.2 micrometers side fringe was generated, when the off-track of the about 2.2 micrometers was not carried out, to a signal output having not carried out nominal cost to zero level, by the disk of this invention, there is no generating of a side fringe at MFM observation, and the signal output fell to zero level on the 2-micrometer off-track, i.e., adjoining truck.
[0068] Furthermore, as a result of performing signal record on three trucks which adjoin each other on the same frequency, then recording the signal of one 1.5 times the frequency of this on the truck of middle and investigating an exaggerated light property and a cross talk property, while gathering the signal of an adjoining truck, there is no adjoining truck signal and sufficient exaggerated light property was acquired with the disk of this invention to having been hard to acquire sufficient exaggerated light property by comparison disks A and B. Therefore, it was proved that the example disk C had big effectiveness to narrow-track-izing.
[0069] Next, the contact start stop trial (henceforth a CSS trial) was presented with three kinds of disks of the example disk C and the comparison disks A and B, and the abrasion resistance was investigated in order for one of the further effectiveness of this invention to clarify. Protection-from-light observation was carried out and the CSS trial investigated investigating time amount (warm-up time) until it results [from revolution starting of a disk] in a rated revolution, and the disk surface state after 50,000 pass trials. By the comparison disk A of only the lubricant which does not have the protective coat on the flat magnetic film, warm-up time showed the unusual value of several 10 seconds with hundreds pass extent, and, as for the comparison disk B which has both the protective coat of structure, and a lubricant conventionally, after 50,000 pass maintained about 2.5 seconds and normal values, as for warm-up time. It is SiO2 although it does not have a protective coat on the magnetic film of this invention to these. By the example disk C which has a guard band, the same result as the comparison disk B was obtained, and, especially as for wear, the result of protection-from-light observation was not accepted, either. Thereby, since it ran while the head was guided by the hard guard band member, even when the example disk C had no protective coat, it could prove that the same strong abrasion resistance as a case with a protective coat was shown, and it was checked that it is advantageous also when [narrow] spacing-izing.
[0070] Furthermore, the head load was made to increase in the condition of having energized to the reproducing head in order to prove a predominance in magneto-resistive effect reproducing-head playback, the head was contacted to the medium side, and the driving test was performed. By the comparison disk A, regenerative-signal reinforcement fell below to one half at the contacted flash. This is because the current shunted toward the conductive recording layer.
[0071] Moreover, by the disk B for a comparison, even if it carried out contact transit, lowering of a regenerative signal was not seen, but when the trial which performs contact actuation continuously was performed several times, there was a case where a signal stopped coming out suddenly. When the magnetic head [a signal] no longer coming out of was investigated, having resulted in dielectric breakdown became clear. Since the protective coat of a disk is insulation, static electricity accumulates this in revolution actuation, and since it concentrated on the head and caused discharge, it is considered.
[0072] On the other hand, by the example disk C, although the regenerative-signal reinforcement at the time of contact transit fell about 10% rather than the time of floatation, even if it performed the contact playback trial continuously, dielectric breakdown was not generated at all. It is because lowering of a signal is isolated with the guard band of insulation [recording layer / of conductivity / one / few] compared with the comparison disk A, and it is thought of because the disk side is not thoroughly covered by the insulating protective coat that dielectric breakdown does not occur.
[0073] Although the above-mentioned example described the case where especially a substrate layer was not prepared, using CoPt as a record magnetic material, this invention can receive definition neither in the class of record ingredient, nor especially the existence of a substrate, but can use freely CoNiPt, CoCrPt, CoTaCr, CoNiCr, CoCr of vertical magnetization, etc. as a record ingredient. Moreover, even if the NiP deposit, Cr orientation control layer or a NiFe soft magnetism layer, etc. is prepared in the substrate, it can carry out.
[0074] Furthermore, a guard band member is not restricted for seeing, although shown in drawing 1 and drawing 6 . As shown in drawing 7 , cross-section [of V characters]-like guard band member 4b may be prepared to the middle of the thickness of magnetic member 2a. Such guard band member 4b is formed by using the special etching method while controlling the crystal orientation of magnetic member 2a in the

predetermined direction. In addition, guard band member 4b may be a cross-section ellipse configuration besides the shape of the cross section of V characters.
[0075] Moreover, as shown in drawing 8 , cross-section rectangle-like guard band member 4c may be prepared to the boundary of the substrate layer 5 of the lower part of magnetic member 2c, and a substrate 1. Such guard band member 4c can be formed also to the medium which has the substrate layer 5, and record playback of high density can be realized.
[0076] Furthermore, as shown in drawing 9 , 4d of guard band members of a cross-section ellipse configuration may be formed so that it may enter into a part of substrate 1a. In the medium 1 without a substrate layer, 4d of such guard band members can be formed to the middle of substrate 1a, and record playback of high density can be realized.
[0077] According to this invention, by separating the record magnetism member of each other by the hard guard band member, a side fringe is reduction-ized substantially and narrow track-ization becomes easy. moreover, the place which high endurance can be attained even if there is no protective coat, ** spacing-ization becomes easy, and ** bit pitch-ization becomes easy, and contributes to the densification of magnetic recording synthetically -- it is great. Furthermore, the magnetic disk which can be formed and its manufacture approach of a hard guard band member are offered, without causing expensive rank-ization.
[0078] Moreover, the degree of freedom to the film which is arranged in the recording layer lower part according to this invention is high, and when it is a medium within a field, it becomes easy it to become easy to carry out to arrange the orientation control film etc. and to set record magnetism thickness as the thinness corresponding to high density record, it to carry out to arrange a high permeability layer in the recording layer lower part by the vertical medium etc., and to strengthen a record playback field. Moreover, since CSS resistance can be substantially improved by adopting a hard guard band member, it is fully applicable also to a contact recording method in the future. Furthermore, if an insulating guard band member is adopted, it will also be possible to contact a magneto-resistive effect mold head to a disk side, and it will contribute to the densification of magnetic recording dramatically synthetically.
[0079] Next, a magnetic recording medium and the magnetic head are explained, referring to drawing 10 - drawing 13 .
[0080] As shown in drawing 10 , a disk 1 is laid on the turntable of a magnetic recording medium 20, and the spin revolution of the disk 1 is carried out by the spindle motor 21. The magnetic head 22 is formed in the point of an arm 28. The end face section of an arm 28 is supported by the voice coil motor (VCM) 29.
[0081] As shown in drawing 11 , it connects with each of the spindle driver 31, the VCM driver 39, and the hard disk drive (HDD) controller 33, and a microprocessor 35 sends a control signal to these. This microprocessor 35 performs both servo control and data processing. For example, in order to control actuation of VCM29, while a microprocessor 35 performs per second 3000 samplings, it generates the digital signal for servo control. D/A conversion of this digital signal is carried out, and it is used for control of the VCM driver 39. Actuation control of VCM29 as an actuator of an arm 28 is carried out by this, and the magnetic head 22 is approached or contacted in the request part of the recording surface of a disk 1. Moreover, a microprocessor 35 controls a motor 21 and the spindle driver 31 so that a disk 1 rotates at a request rate.
[0082] Furthermore, processing of writing/read-out is also performed under the monitor of a microprocessor 35. That is, a microprocessor 35 exchanges the HDD controller 33 and a signal, signal-izes the data which should be recorded on a disk 1, and sends this to the magnetic head 22 through the read/write circuit 32. On the other hand, the HDD controller 33 is connected to the external host computer (not shown) through the host interface 34. The data which should be recorded on a disk 1 are inputted into the HDD controller 33 from a host computer, this input data is once sent to a microprocessor 35, data processing is carried out by the microprocessor 35, and this is further returned to the HDD controller 33. In addition, when two or more heads are carried in the arm 28, a microprocessor 35 performs these multiplexing processings.
[0083] Next, the magnetic head is explained, referring to drawing 12 and 13.
[0084] Drawing 12 is drawing having shown the theoretic configuration of the magnetic-head unit 22 typically. A recording head 23 and the reproducing head 24 are carried in the magnetic-head unit 22. A recording head 23 is an induction type head equipped with the device in which the coil was wound around a record magnetic pole which is usually used thin film type. This recording head 23 records a data signal on a magnetic disk 1 by supplying the record current according to a data signal from record amplifier (not shown) through a terminal 25.

[0085] The reproducing head 24 is a giant magneto-resistance mold head (GMR head) which used the spin bulb mold magnetic resistance element (MR component). This reproducing head 24 reproduces the data signal recorded on the magnetic disk 1, and the servo signal beforehand recorded in advance of record of a data signal. A sense current is supplied to MR component of the reproducing head 24 from a sense circuit (not shown) through a terminal 26. Moreover, change of the magnetic reluctance of MR component by the field based on the signal recorded on the magnetic disk 1 is taken out from a terminal 26 as the electrical-potential-difference change by the sense current, i.e., a voltage signal, and this voltage signal is supplied to playback amplifier (not shown).
[0086] As shown in drawing 13 , the spin bulb mold MR component of a recording head 23 equips pin layer (1st magnetic layer) 23a, free layer (2nd magnetic layer) 23b, nonmagnetic conductive layer 23c, and a list with 1 pair of lead 23d. As for pin layer 23a, magnetization is being perpendicularly fixed to the field of a magnetic disk 1. As for free layer 23b, magnetization changes with impression fields. Nonmagnetic conductive layer 23c is inserted between pin layer 23a and free layer 23b. It connects with the truck cross direction both ends of pin layer 23a 1 pair of lead 23d. The terminal 25 is connected to each lead 23d, respectively. Each terminal 25 is connected to the read/write circuit 32.
[0087] Pin layer 23a and free layer 23b consist for example, of Co-Fe film, and nonmagnetic conductive layer 23c consists for example, of Cu film. Here, orientation of the free layer 23a is carried out so that magnetization may be equal to a magnetic-disk side in parallel crosswise [truck]. If a signal field is impressed to MR component of a recording head 23, the magnetization direction of free layer 23b will be decided, and the electric resistance of MR component seen among [one pair of] lead 23d by the relation between the magnetization direction of this free layer 23b and the magnetization direction of pin layer 23a will change. The change phenomenon of this electric resistance is giant magneto-resistance.
[0088] Next, the gestalt of other desirable operations of this invention is explained, referring to drawing 14 - drawing 19 .
[0089] By drawing 14 , in a substrate and a sign 2, a recording layer and a sign 11 show a magnet member, and a sign 12 shows [sign 1a] a record magnetism member, respectively. this operation gestalt -- as a record magnetism member 12, the TbCo film of 20nm thickness was used as a magnet member 11, and the glass substrate of the diameter of 2.5 inch was respectively used for the CoPt film of 20nm thickness as substrate 1a.
[0090] The recording layer 2 equips the disk radial with the magnet member 11 and the record magnetism member 12 by turns. The record magnetism member 12 forms recording tracks T1 and T2 and --Tn, respectively, and the magnet member 11 forms the fields M1 and M2 between recording tracks and --Mn which generate a direct-current field, respectively. In the case of a longitudinal record medium, the sense of magnetization of the record magnetism member 12 is parallel to a recording track, and, in the case of a vertical recording medium, it is vertical to a film surface.
[0091] On the other hand, when operating the sense of magnetization of the magnet member 11 by the magnetoresistive head of a horizontal energization method, it is vertical to a film surface, and when making it operate by the magnetoresistive head of a vertical energization method, it is vertical to recording tracks T1 and T2 and --Tn within a film surface. In addition, even if it is a horizontal energization method and is a vertical energization method, the sense of magnetization of the magnet member 11 is good to set it as the reverse sense for every truck.
[0092] Magnetic-disk 1D shown in drawing 14 can be manufactured by the following approaches. On glass substrate 1a which constitutes a flat side, the flat CoPt film is formed by sputtering, and it continues first, and is SiO2. The film is formed to 10nm thickness. Subsequently, SiO2 The spin coat of the resist is carried out on the film, using the laser aligner used for original recording cutting of an optical disk, a resist is exposed concentrically, a development is carried out, and patterning of a resist is performed.
[0093] Next, a substrate 1 is inserted in in an RIE system, for example, it is CHF3. SiO2 film is etched using gas. Furthermore, ashing removes a resist pattern and it is SiO2 on the CoPt film. A pattern is formed. Subsequently, it etches until it reaches [chlorine] a substrate side in a CoPt magnetic film using the mixed gas of boron trichloride with an RIE system.
[0094] Furthermore, the excessive TbCo film which formed the TbCo perpendicular magnetic anisotropy films of the high coercive force (10kOe extent) near a compensation presentation (Tb;22 atom % extent) to 20nm

thickness magnetically using the sputtering system, and was formed on the record magnetism member 12 using ion polishing equipment after that was removed, and magnetic-disk 1D was obtained.
[0095] Rather than the CoPt film used for the record magnetism member 12 by the amorphous alloy, since the TbCo film used as a magnet member 11 was a high degree of hardness, disk assessment was presented with it, without forming especially a protective coat as it is.
[0096] By the way, before presenting assessment with the obtained disk, it is necessary to set up the initial magnetization direction of the magnet member (magnet layer) 11. This was performed using the magneto-optic-recording equipment equipped with the Ayr spindle motor in which high-degree-of-accuracy positioning is possible. First, disk 1D is installed in magneto-optic-recording equipment. And impressing a record field vertically to a film surface, and carrying out vertical reversal of the sense of a record field for every truck, convergent radiotherapy of the semiconductor laser light was carried out to the TbCo film 11, it continued facing up or downward on one truck, membranous magnetization was prepared uniformly, and the optical head was concentrically sent to the disk radial by the 2-micrometer track pitch. Thus, disk 1D to which the magnetization direction of the magnet layer 11 was set was installed in the magnetic-recording playback testing device, and was evaluated.
[0097] Drawing 15 is the mimetic diagram expecting and showing the magnetic-reluctance playback mold magnetic head used for the assessment trial of magnetic-disk 1D from the ABS side of the playback section. The magnetic head shown in drawing 15 is specially made as an experiment, in order to evaluate magnetic-disk 1D of this operation gestalt. the inside of drawing -- in the magnetization revolution film and a sign 42, a conductive nonmagnetic membrane and a sign 8 express the magnetization fixing film, and, as for a sign 6, the magnetization fixed film and a sign 7 express [a sign 41] an electrode layer, respectively.
[0098] the magnetization revolution film 41 and the magnetization fixed film 42 -- the CoFe film -- FeMn was used for the magnetization fixing film 8, and Cu was respectively used for the conductive nonmagnetic membrane 7 for Cu at the electrode layer 6. The sense of the magnetization of the magnetization fixed film 42 by which presents heat treatment among the field in a vacuum by the final process of a head prototype, and switched connection is carried out to the magnetization fixing film 8 and it was set as the sense (namely, direction vertical to a medium side) which goes to a background from the space side front of drawing 15 .
[0099] The actually used head formed the NiFe up magnetic pole in the upper part through an insulator layer, magnetic shielding, the CoZrNb film that served both as the bottom magnetic pole of record, and a record gap, and record and regenerative-track width of face were set to 2 micrometers. The magnetic disk of this example was rotated, the magnetic head was surfaced by 0.04 micrometers of flying heights, and the record playback trial was carried out. Consequently, with the magnetic disk of this example, since the magnetic signal from the record magnetism member 12 differed from the magnetic signal from the magnet member 11 also in the condition of not recording, it was stabilized even if it was the case where especially a servo light was not carried out, and tracking actuation was able to be realized. One of the effectiveness of this invention was proved [this].

[0100] Next, as shown in drawing 16 , informational record playback was performed to magnetic-disk 1D of this operation gestalt using the above-mentioned magnetic-reluctance playback mold magnetic head. Drawing 16 is the cross section showing the appearance of the magnetization revolution film 41 of a head, and a record medium which runs the recording track top in the working condition of not recording.
[0101] Impression of the record signal to a record magnetic pole and the horizontal energization (it energizes to the reverse sense to the arrow head illustrated in the magnetization revolution film 41 in drawing 15) to the reproducing-head electrode 6 performed record playback actuation. The sense of magnetization of the magnetization revolution film 41 on a truck T2 is a set, and this is the magnetization direction in which symmetry waveform regeneration is possible as mentioned above at the sense of the leakage field from the magnet members M2 and M3.
[0102] Next, when record actuation was performed, magnetization of the magnetization revolution film 41 rotated according to the leakage field (it is vertical to a medium side and they are facing up or facing down) from the flux reversal section, resistance changed, and the regenerative signal of a symmetrical-wave form was acquired. Since regenerative-signal reinforcement increased to linearity and the sense of magnetization of a sense current field and the magnetization fixing film 8 was mostly in agreement if a sense current is made to increase, change of the magnetization direction of the magnetization fixing film 8 was not seen.

[0103] When it is made to operate by truck T3 which adjoins a truck T2, the sense of magnetization of the magnetization revolution film 41 turns into reverse sense at the time of a truck T2, but since a truck T2 and T3 were equivalence, record playback actuation of the playback actuation top was able to be carried out without the problem.
[0104] Next, as a result of sending to a non-recorded truck little by little from a truck [finishing / record of the reproducing head] the disk radial and investigating an off-track property, the signal was completely lost by 2-micrometer delivery of a track pitch, and it became clear that it is effective also when disk 1D of this operation gestalt reduces a side fringe. Moreover, although the CSS trial was repeated and was performed 5000 times, especially wear of a medium side was not accepted. However, the lubricant was applied to the medium side and the CSS trial was carried out. From now on, it became clear that the magnet member 11 had the effectiveness of acting in [the magnet member 11] guide rail, and raising CSS resistance if it is hard from the record magnetism member 12 so that clearly.
[0105] Furthermore, when improving CSS resistance, it is effective to use the magnet member of a ferrite system instead of TbCo as a magnet member 11, in such a case, even if he has no protective coat, the practical CSS resistance of 50,000 pass extent is expectable, and the formation top of a ** spacing is also effective [a case]. In addition, in the case of the TbCo magnet layer used for the above-mentioned example, it is about 10nm SiO2 on a medium side. It is desirable practically to prepare a protective coat.
[0106] (Example of a comparison) Although the result of the experiment which clarified effectiveness of this invention was described above, the magnetic disk which does not have a magnet member using the conventional approach as an example of a comparison was created, and this was similarly estimated as disk 1D of the above-mentioned operation gestalt. The configuration of the example disk of a comparison is a 20nm CoPt recording layer and 10nm Si02 on a glass substrate. Spatter formation of the protective layer is carried out, and the lubricant same with having used on it at disk 1D is applied. The conditions of a disk activity trial were made the same as the conditions of disk 1D except for having changed the spacing between a head/media, having used the head flying height as 0.03 micrometers.
[0107] since the field revealed from the example disk of a comparison to the magnetization revolution film 41 of a head is random in the state of un-recording -- the magnetization direction of the magnetization revolution film 41 -- average -- seeing -- the sense of the leakage field of the magnetization fixing film 8 and the magnetization fixed film 42, i.e., drawing 15 , -- space -- being vertical (from a flesh side to a table) -- it is suitable. In case it originated in this and a record magnetic-domain train was reproduced, when the field from the example disk media of a comparison went to a flesh side from the table of space in drawing 15 , magnetization of the magnetization revolution film 41 rotated, the regenerative signal was acquired, but when going to a table from a flesh side, magnetization of the magnetization revolution film 41 did not rotate and a signal was not acquired. That is, by the example disk of a comparison, although the regenerative-signal output was obtained, only the output equivalent to the one half of magnetization transition was obtained.
[0108] Moreover, since tracking information was not acquired at all from the truck in the condition of not recording if he had no servo light in the example disk of a comparison, while producing the truck gap gradually, the side fringe produced the inconvenience that became large and mixing of the excessive noise signal from an adjoining truck became large.
[0109] At an above-mentioned example and the above-mentioned example of a comparison, it is SiO2 as the TbCo film and a protective coat as the CoPt film and a magnet layer as glass and a record magnetic layer as a substrate. Although the used example was described Especially this invention is not limited only to these ingredients. To a substrate metals, such as aluminum Various ingredients, such as C, can be used [a ferrite, SmCo, NdFe MnBi, etc.] for the record magnetism member 12 for CoCrTa, CoNiPt, CoCr, Ba ferrite, etc. as a protective coat again at the magnet member 11. Furthermore, high permeability layers, such as orientation control layers, such as Cr, and NiFe, etc. may be arranged at the substrate of the record magnetism member 11.
[0110] Moreover, a busy modification may be given and the shape of the shape of V character and a semicircle has also as the cross-section configuration of a magnet member in addition to the shape of a rectangle.
[0111] Moreover, although the depth of the field in which the magnet member 11 is formed was made the same as the thickness of the record magnetic layer 12 in magnetic-disk 1D of the above-mentioned operation gestalt, the depth (thickness) of the magnet member 11 does not necessarily require that it is the same as the thickness of the record magnetic layer 12. For example, in disk 1E shown in drawing 17 , the depth of magnet member

11a is made smaller than the thickness of record magnetism member 12a. Moreover, as shown in drawing 18 , it is good disk 1F which have the middle class (substrate layer) 5 between substrate 1a and a recording layer 2 also as what totaled the middle class's 3 thickness, and the thickness of record magnetism member 12b for the depth of magnet member 11b. Furthermore, in disk 1G shown in drawing 19 , the depth of magnet member 11c is made larger than the thickness of record magnetism member 12c.

[0112] Moreover, the same effectiveness can be acquired also to the artificial grid multilayer-structure film, the magneto-resistive effect form playback components, for example, the anisotropy magnetic-reluctance film, other than spin bulb structure, a granular membrane, etc. That is, when acquiring the symmetry of a regenerative signal, the same effectiveness is done so to the magneto-resistive effect component at large which needs a certain operating point bias.

[0113] If the magnetic disk of this operation gestalt is used, in the magnetic recorder and reproducing device which has the magneto-resistive effect mold reproducing head, since a big sense current can be energized, high regenerative-signal reinforcement can be obtained, since the good symmetric property of a regenerative-signal wave is acquired, little playback actuation of an error rate can be stabilized and performed, and since reproducing-head structure is simplified, a head can be manufactured cheaply. the tracking actuation which little record of a side fringe of was still attained as subordinate effectiveness, and was stabilized is possible -- becoming -- narrow-track-izing -- easy -- becoming -- and ** spacing actuation -- possible ** -- it is -- **.

[0114]

[Effect of the Invention] According to this invention, by separating the record magnetism member of each other by the hard guard band member, a side fringe is reduction-ized substantially and narrow track-ization becomes easy. moreover, the place which high endurance can be attained even if there is no protective coat, ** spacing-ization becomes easy, and ** bit pitch-ization becomes easy, and contributes to the densification of magnetic recording synthetically -- it is great. Furthermore, the magnetic disk which can be formed and its manufacture approach of a hard guard band member are offered, without causing expensive rank-ization.

[0115] Moreover, the degree of freedom to the film which is arranged in the recording layer lower part according to this invention is high, and when it is a medium within a field, it becomes easy it to become easy to carry out to arrange the orientation control film etc. and to set record magnetism thickness as the thinness corresponding to high density record, it to carry out to arrange a high permeability layer in the recording layer lower part by the vertical medium etc., and to strengthen a record playback field. Moreover, since CSS resistance can be substantially improved by adopting a hard guard band member, it is fully applicable also to a contact recording method in the future. Furthermore, if an insulating guard band member is adopted, it will also be possible to contact a magneto-resistive effect mold head to a disk side, and it will contribute to the densification of magnetic recording dramatically synthetically.

[0116] According to the magnetic disk of this invention, since the suitable operating point bias for a magneto-resistive effect form head is impressed by the medium field, even if it uses easy playback component structure, the playback actuation by which the symmetrical-wave mold was stabilized is attained, and manufacture of a playback component becomes simple.

[0117] Since it becomes possible to be stabilized and to carry out tracking actuation of high degree of accuracy, and little record of a side fringe can be realized and it becomes easy to carry out ** spacing actuation even if it is the case where especially a servo light is not carried out, the place which contributes to the densification of magnetic recording and high performance-ization synthetically is size.

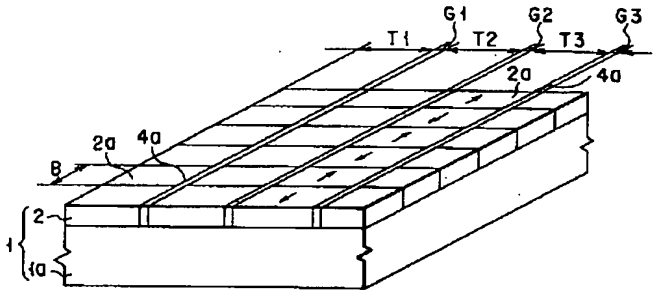
[Translation done.]

* NOTICES *

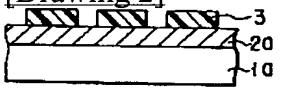
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

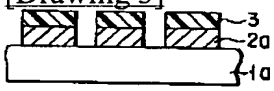
[Drawing 1]



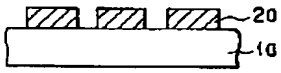
[Drawing 2]



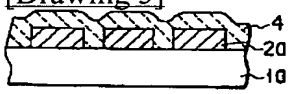
[Drawing 3]



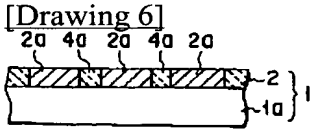
[Drawing 4]



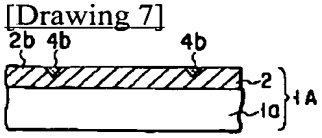
[Drawing 5]



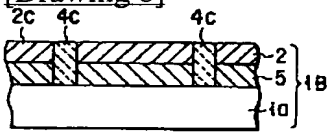
[Drawing 6]



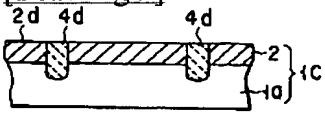
[Drawing 7]



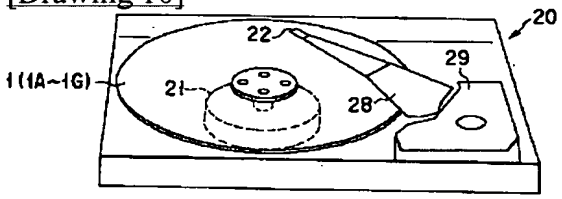
[Drawing 8]



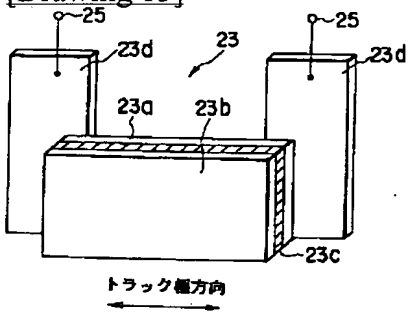
[Drawing 9]



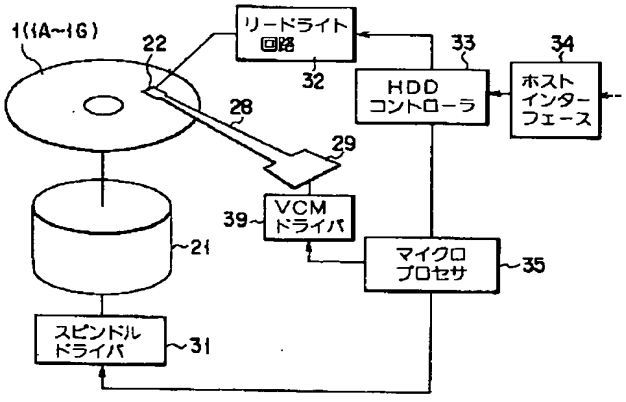
[Drawing 10]



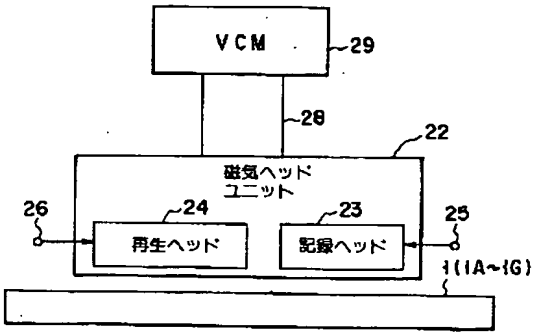
[Drawing 13]



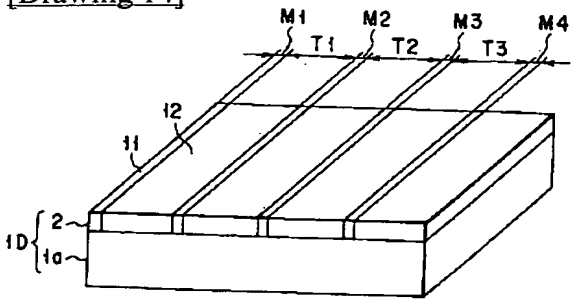
[Drawing 11]



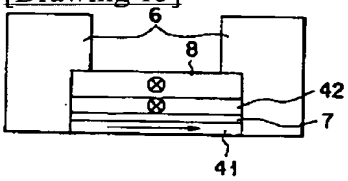
[Drawing 12]



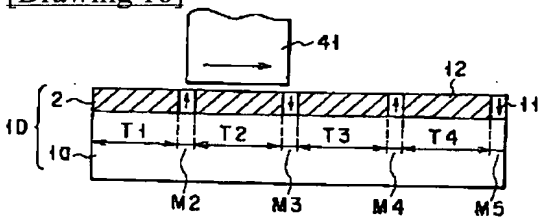
[Drawing 14]



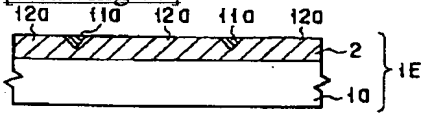
[Drawing 15]



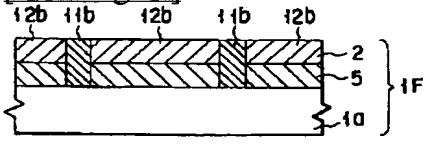
[Drawing 16]



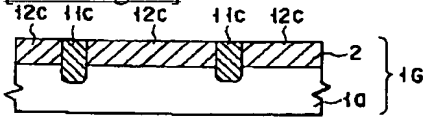
[Drawing 17]



[Drawing 18]



[Drawing 19]



[Translation done.]

* NOTICES *

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Category partition] The 4th partition of the 6th category
[Publication date] October 12, Heisei 13 (2001. 10.12)

[Publication No.] JP,9-97419,A
[Date of Publication] April 8, Heisei 9 (1997. 4.8)
[Annual volume number] Open patent official report 9-975
[Application number] Japanese Patent Application No. 8-191846
[The 7th edition of International Patent Classification]

G11B 5/82
5/012
5/39
5/84

[FI]

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5/012
5/39
5/84 Z

[Procedure amendment]
[Filing Date] January 16, Heisei 13 (2001. 1.16)
[Procedure amendment 1]
[Document to be Amended] Description
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] In the magnetic disk possessing the guard band member which was prepared in a substrate and this substrate, was prepared between the recording track section formed by the magnetic member which carries out record playback of the information magnetically, and the recording track section which adjoins mutually, was [making it continuously] harder than the magnetic member in the direction of a truck, and was substantially formed in it by the non-magnetic material in the recording track section,
A magnetic member is not prepared in the lower part field of said guard band member which has equal thickness substantially in the thickness of the magnetic member which forms said recording track section, but the magnetic member of said recording track section has magnetic shape anisotropy in the direction of a truck,
The magnetic disk with which the disk side formed of the magnetic member which forms said recording track section, and said guard band member is characterized by having an even field.
[Claim 2] In the magnetic disk possessing the guard band member which was prepared in a substrate and this substrate, was prepared between the recording track section formed by the magnetic member which carries out

record playback of the information magnetically, and the recording track section which adjoins mutually, was [making it continuously] harder than the magnetic member in the direction of a truck, and was substantially formed in it by the non-magnetic material in the recording track section,
It has thin thickness more nearly substantially than the thickness of the magnetic member which forms said recording track section, and has the magnetic member prepared in the lower part field of said guard band member,
The magnetic disk with which the disk side formed of the magnetic member which forms said recording track section, and said guard band member is characterized by having an even field.
[Claim 3] A magnetic disk given in either of claims 1 or 2 to which the way of the electric resistance of said guard band member is characterized by being larger than the electric resistance of the magnetic member of said recording track section.
[Claim 4] Furthermore, it has the substrate layer which consists of a NiP deposit, Cr orientation control layer, or the NiFe soft magnetism layers between the magnetic member of said recording track section, and a substrate, The thickness of said guard band member is a magnetic disk given in either of claims 1 or 2 characterized by the thickness which totaled the thickness of said substrate layer, and the thickness of the magnetic member of said recording track section, and the substantially same thing.
[Claim 5] Said guard band member is a magnetic disk given in either of claims 1 or 2 characterized by being formed with one of polymerization compounds among a nitride like SiO2, aluminum2O3, an oxide like TiO2, Si3N4, and AlN and TiN, carbide like TiC, boride like BN or C system, CH system, or CF system.
[Claim 6] A magnetic disk given in either of claims 1 or 2 to which width of face of said recording track section on said disk side is characterized by spacing of the pitch of 0.2**0.1 micrometers and said recording track section totaling [the width of face of 1.8**0.1 micrometers and said guard band member] the width of face of said recording track section, and the width of face of said guard band member.
[Claim 7] A magnetic disk given in either of claims 1 or 2 characterized by each of said recording track section and said guard band member forming the exposure disk side.
[Claim 8] A magnetic disk given in either of claims 1 or 2 characterized by covering said disk side by the protective coat in order to protect each of said recording track section and said guard band member.
[Claim 9] A magnetic disk given in either of claims 1 or 2 characterized by said magnetic member consisting of an ingredient formed by the plural magnetron sputtering method.
[Claim 10] The magnetic disk according to claim 9 characterized by said ingredient being CoPt carried out 20 atom % content about Pt.

[Translation done.]

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